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DIMENSION-STOCK METHODS FOR NEW ENGLAND HARDWOODS

By

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INTRODUCTION

Dimension stock is defined broadly as the wood cuttings or parts, either rough or finished, used in the products of furniture, automobile, casket, turning, and other woodworking factories.

The Forest Service through the Forest Products Laboratory has been engaged in the study of dimension-stock production and use for many years. The use of dimension stock means less waste, fewer manufacturing processes, and the utilization of material otherwise unmerchantable. The more general acceptance of dimension stock as a suitable alternate for long, wide lumber would be a forward stride in the conservation of our better hardwood timber and would aid in stabilizing many secondary wood-using industries.

Dimension-stock manufacture has been modernized. Changes in woodworking practice ordinarily come about slowly, but the change in dimension-stock practice has been rapid. The methods and equipment now employed are a wide departure from those formerly used. High-speed production demanded short-cuts and in many wood-using industries dimension stock proved to be a short-cut to more satisfactory supplies of raw material. Shorn of the objections so common to dimension stock marketed a number of years ago, the new

[1] Acknowledgment is made to C. V. Sweet, in charge of the section of industrial investigations, and to various other members of the Forest Products Laboratory, for assistance in the preparation of this circular. Further acknowledgment is also made to the hearty cooperation received from timberland owners, sawmill operators, and many others.

[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

product met the tests imposed on it and became firmly entrenched as a standard form of raw material.

Among the factors essential to success in dimension-stock manufacture two are of particular significance, namely, good equipment and good methods. This circular presents information on equipping and operating a dimension-stock mill. It aims to simplify the problems confronting a prospective operator or one contemplating changes in an established plant. The mill planned is a composite of a large number of plants employing a wide variety of machines, lay-outs, and operating methods. The machines suggested are those which have given proof that they are particularly well adapted to a plant of this type.

Much of the forest land in New England is better adapted to growing timber than to any other crop. The revenue from forest land is normally low. To keep on the profit side of the ledger it is essential that the fullest possible use be made of the products of the land. Good forest management and a sustained-yield program are built on complete utilization. Dimension-stock manufacture fits well into the scheme because it offers a means by which raw material may be used with relatively little waste. Important from the standpoint of permanent forest communities is the fact that, for equal volumes of product, dimension-stock manufacture requires more man-hours of labor than does lumber. In other words, the manufacture of dimension stock keeps more men employed at the mill than does the manufacture of an equal amount of lumber that is later cut up at the factory into the sizes needed for the final product. Small labor groups close to the log supply admit of considerable flexibility in plant operation without hardship to employees. On the other hand, employees in congested industrial centers are dependent for their well-being upon uninterrupted operation of the factories.

Broadly speaking, the timber of New England does not yield lumber of a quality that competes successfully with lumber from other timber-producing regions. Because of its low average quality, lumber produced in New England cannot be transported long distances. On the other hand, New England timber when cut into dimension stock can be shipped as far and handled as economically as competing woods from other regions. Quite as serious is the fact that woods from other regions, even the same species as grown in New England, have been shipped in to meet the needs of New England wood-using plants. A natural conclusion is that the possibilities of New England woods have not been developed. There has been too little interchange of ideas between the producer and user of wood and too little thought given to modernization of sawmill methods and manufacturing practices in general. There has been little concerted effort to place New England woods in markets where they might compete on even terms with other woods of similar inherent values.

Essentially, the effective utilization of New England woods for factory purposes lies in the development of economical methods of handling small timber. Proportionally the waste of material in smaller sizes is greater than in larger sizes and the handling costs are also greater. To offset such obvious handicaps it is necessary to use equipment and methods that are especially effective in working with small material. A sawmill designed to handle effectively logs

up to 30 inches in diameter cannot be expected to be at its best on logs 10 inches in diameter. The logical procedure when using logs of small diameter is to use a sawmill built especially for the purpose. The same principle applies to many of the processes involved in preparation of dimension stock for market.

SIZE OF STOCK DEMANDED IN VARIOUS INDUSTRIES

There is an erroneous impression that wood-using industries demand long, wide, clear cuttings whereas the actual requirements are for comparatively small pieces (fig. 1). Accurate determinations for a group of the leading wood-using industries have shown that, excluding flooring, 50 percent of all cuttings are 4 inches or less in width, 33 percent are from 4¼ to 8 inches in width, and only 17 percent 8¼ inches or over. These percentages are based on volume consumption in board feet.

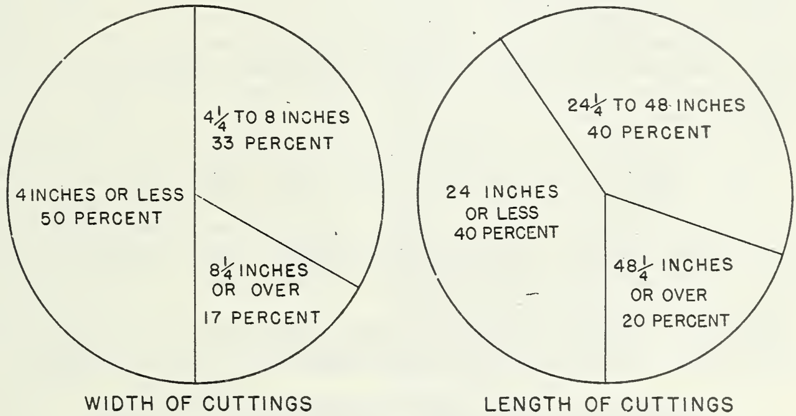

FIGURE 1.—Size of stock required by the leading wood-using industries.

Similarly for length, excluding flooring, 40 percent of the volume of material used by the leading industries is in cuttings 24 inches or less in length, 40 percent is in lengths 24¼ inches to 48 inches, and only 20 percent is 48¼ inches or over. These figures are significant. The fact that the requirements are so moderate that 50 percent of the used volume of cuttings is in widths 4 inches or less and 80 percent in cuttings 48 inches in length and under is substantial support for the contention that, properly handled, small timber can economically be made to meet the ordinary needs of the wood-fabricating industries. There will always be some uses where the requirements can more easily be met by larger timber but the actual necessity for long, wide cuttings is relatively small.

SOURCES FOR DIMENSION STOCK

Dimension stock is cut directly from large logs, small logs, short bolts, round-edged lumber, square-edged lumber, tie siding, and sawmill waste. All these sources may be used with success provided

proper methods and equipment are employed. Logs as small as 8 inches in diameter can be used for dimension stock, but this is about the minimum profitable size.

Round-edged lumber is an economical form of material from which to cut dimension stock. Low-grade logs yield a greater volume of dimension stock than does square-edged lumber. It is good practice at plants equipped with satisfactory drying facilities to cut bolts directly into dimension stock and to air-dry or kiln-dry the material at once to proper moisture content. Without satisfactory drying facilities it is preferable first to cut the bolts into planks, then dry the planks, and finally cut them into dimension stock.

So-called mill waste—slabs, edgings, trimmings, and cull lumber—has been used for many years as a source for dimension stock in the form of squares. Many hardwood sawmills have sought unsuccessfully to increase their profit from logs by remanufacturing mill waste. Reasons for failure have been very apparent. Dimension stock as a side issue has been poorly manufactured, poorly dried, and inefficiently marketed. The result has been damaging to the reputation of dimension stock in the wood-using industries. On the other hand, there have been some producers who have made a success of dimension-stock manufacture from mill waste, particularly those producers who have studied the needs of wood users.

Tie siding yields high-grade dimension stock. The side boards cut off in squaring ties are freer from knots than the part of the log closer to the heart center. Since tie siding is usually considered purely a by-product of ties it bears a market price under that for square-edged lumber of comparable quality. Tie siding is available in the New England States only in a few species, chiefly oak and maple.

Long logs of inferior quality for long, wide lumber can be cut into short, clear, straight bolts that make high-grade dimension stock.

TYPICAL USES FOR DIMENSION STOCK

The following is a list compiled by the Forest Products Laboratory of present uses for dimension stock. The list is not complete, but nevertheless it indicates that dimension stock (fig. 2) is used in most of the many branches of the woodworking industry. It is true that the practices of individual firms within each branch vary considerably. For an identical product one company may use dimension stock exclusively whereas a neighboring company may use lumber exclusively. Then again a company may alternate between dimension stock and lumber depending upon comparative prices of the two, upon availability of satisfactory stock, upon factory facilities for drying and cutting up lumber, upon the satisfaction experienced in previous use of dimension stock, and upon various other factors. Certain duplications in this list are unavoidable. For instance, the term "furniture" is a very inclusive one; consequently, simply to list furniture is not only misleading but is of indefinite informational value. Therefore, while furniture is set down as one

item there are other furniture items listed so that it is possible to determine more closely for just what types of furniture dimension stock is used.

Automobile body parts.
Automobile top bows.
Automobile running and floor boards.
Athletic goods.
Bases, lamp.
Bats, baseball.
Beads.
Beams, plow.
Benches, park, piano.
Blocks, toy.
Boards, bread, ironing, meat, noodle, pastry, shredding, skirt, sleeve, spaghetti, stove, wash.
Boats, toy.
Bobbins, sawed billets.
Boxes, ornamental.
Brush backs.
Brush rolls.
Bungs.
Buttons.
Cabinets, display, filing, kitchen, medicine, sewing, tool.
Carriages, baby.
Cars, kiddie, toy.
Case goods.
Cases, book, display, filing, jewel.
Caskets.
Chests, clothes, tool.
Cobs, insulator.
Cores, glued-up, for dresser tops, and table tops.
Costumers.
Crates, milk.
Croquet sets.
Cues, billiard.
Desks, office, school, spinet.
Dowels.
Drawer parts.
Equipment, playground.
Firearms.
Fixtures, commercial.
Flag sticks.
Flooring, parquet, display window.
Frames, picture, furniture, window, and door screens.
Furniture.
Furniture frames.
Furniture, camp, juvenile, lawn, outdoor.
Grill work.
Handles, broom, brush, mop, tool.
Hangers, coat.
Harrows.
Heels, wood.
Implements, agricultural.
Instruments, scientific.
Ladders, rails, rungs, treads.
Lattice work.
Levels, spirit.
Machinery, bases, parts.
Machines, sewing, washing
Mallets.
Moldings.
Neckyokes.
Novelties.
Penholders.
Pens, play.
Pianos, legs.
Pins, insulator.
Pipes, smoking.
Playground equipment.
Plumbers' woodwork.
Poles, curtain, pruner.
Posts, bed, buffet, chair, dresser.
Racks, book, hat, magazine, newspaper.
Radio, miscellaneous parts.
Rails, bed, chair, table.
Rakes.
Refrigerators.
Rollers, map, shade.
Rulers.
Seating.
Settees.
Shuttles.
Signs.
Skiis.
Sleds.
Slides, table.
Spindles, chair, railing, stair.
Spokes, auto, carriage, wagon.
Spool barrels, for large spools, for photographic films.
Spools.
Sporting goods.
Staffs, flag.
Stands, hat, magazine, telephone, smoking.
Stools.
Stretchers, chair.
Swings, lawn.
Tables, card, miniature billiard, ping pong.
Tennis rackets.
Thresholds.
Toilet seats and tanks.
Toys.
Trays, knife and fork, milk bottle, ornamental, trunk.
Treads, stair.
Trellises.
Trunks, slats, trays.
Turnings.
Vehicles.
Ventilators.
Wagons, coaster, farm.
Wardrobes.

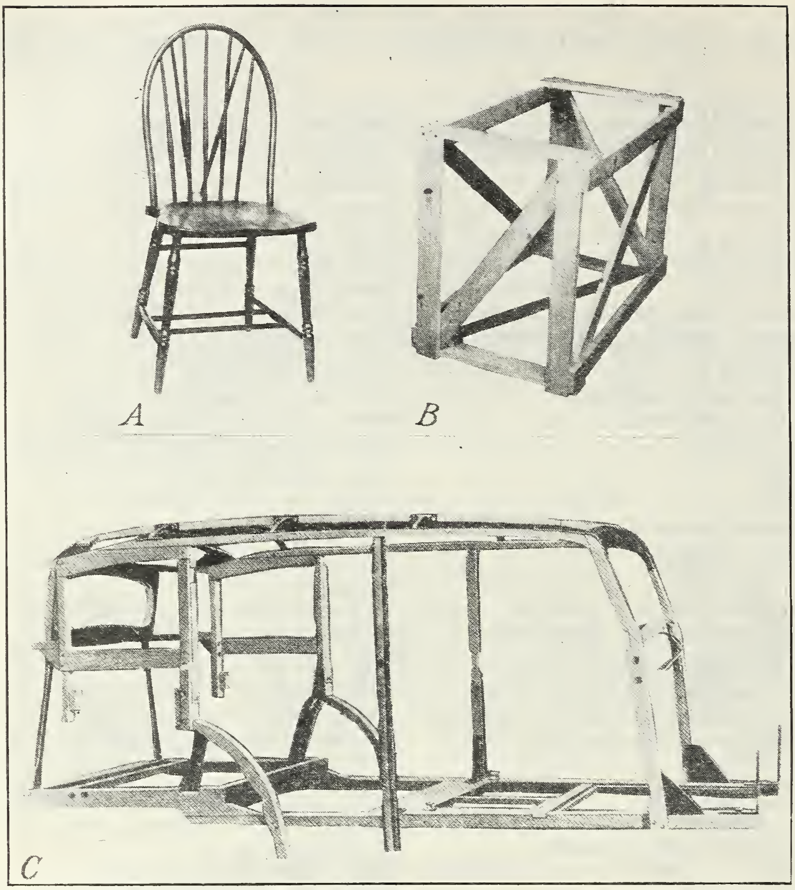

FIGURE 2.—Typical uses of dimension stock: *A*, Chair; *B*, crate; *C*, automobile body frame.

MARKETING DIMENSION STOCK

The real test of a dimension-stock manufacturer's ability is marketing his product. Some sizes of stock move easily and with a fair margin for profit, but other sizes, chiefly the small ones are difficult to dispose of at prices that will cover costs. In order to utilize raw material effectively it is necessary to cut a considerable amount of small stock. Special effort should therefore be made for the sale of small stock. Common practice has been to dump accumulations of small stock on the market at prices below cost of production thus not only causing immediate losses to the producers directly concerned but also demoralizing the market for others.

No millman should go into the production of dimension stock on a large scale without first having received specific orders for certain sizes. Sizes cut at random with the idea of recutting stock to meet orders received later is poor practice. Reworking stock necessitates additional handling and machine operations at prohibitive cost.

DIMENSION-STOCK EQUIPMENT FOR SAWMILLS AND PLANTS OPERATED EITHER JOINTLY OR UNDER THE CONCENTRATION PLANT SYSTEM

Efficient equipment is one of the chief factors that determine successful and economical operation of dimension-stock mills. This does not imply that equipment must be new, costly, or complicated, but it must be designed with a view to minimizing labor, material, and maintenance costs, and it must be capable of precise work.

The following general discussion of equipment suitable for the complete manufacture of dimension stock from New England woods applies especially to sawmills and plants operated either jointly or under a concentration system. A steady production of 8,000 board feet of dimension stock per 10-hour shift is a fair output. Suggestions for buildings, equipment, and labor are therefore based on the needs of a cut-up plant of 8,000 board feet capacity. A sawmill operated in conjunction with this cut-up plant should have a capacity of 12,000 board feet of lumber per day. The difference between the 12,000 board feet of lumber and the 8,000 board feet of dimension stock represents the unavoidable waste that occurs in cut-up operations. To cut 12,000 board feet per day the sawmill equipment suggested must be in prime working condition, the log supply constant, and the logs not too small or too defective.

On the basis of an output of 12,000 board feet per day of 10 hours the total power available for the sawmill should be 75 horsepower. This computation is made on the assumption that the power requirement would be about 6 horsepower per 1,000 board feet of output.

The ordinary type of small sawmill, the so-called portable type of mill common in New England, will do well to average 3,000 or 4,000 board feet of output per day. A dimension-stock plant with an 8,000-board-foot capacity per day would therefore handle the lumber from about four small outlying sawmills provided such mills operate throughout the year. If they operate only one-half of the time the product of six or eight mills would be required. The excess cut during the operating season would have to be stored either at the outlying sawmills or at the concentration plant. If the concentration plant started its dimension-stock operations on air-dry lumber the plan of using the product of eight small mills would work out very well for the reason that there would at all times be a 6 months' supply of air-dry lumber on which to draw.

With the foregoing capacities in mind the following discussion of suitable equipment is divided into two parts: (1) Sawmill equipment, and (2) dimension-stock plant equipment.

SAWMILL EQUIPMENT

The equipment required for a sawmill, operated either as an integral part of a dimension-stock plant or purely as an outlying feeder mill for a concentration plant, consists of a log cut-off saw, a head saw to cut logs or bolts into boards, a trim saw, and a slash saw to cut the slabs into desirable shorter lengths. Other desirable equipment are a slab resaw and an edger. The resaw facilitates the

recovery of good material otherwise lost in slabs, and the edger facilitates the manufacture of square-edged long lumber.

The total cost of the sawmill equipment described on the following pages amounts to approximately $8,000 at 1932 prices.[3]

LOG STORAGE

Where there is likelihood of a considerable accumulation of logs at the saw mill the arrangement of the log yard should be carefully planned. Whether the logs come in by rail or by truck there should be ample unloading space (fig. 3). Logs should be unloaded directly from cars or trucks into the log pond or to rollways so located that delivery to the log deck will be accomplished with a minimum of handling.

A log pond is a desirable storage arrangement and snould be provided wherever the site permits. A pond should be large enough to

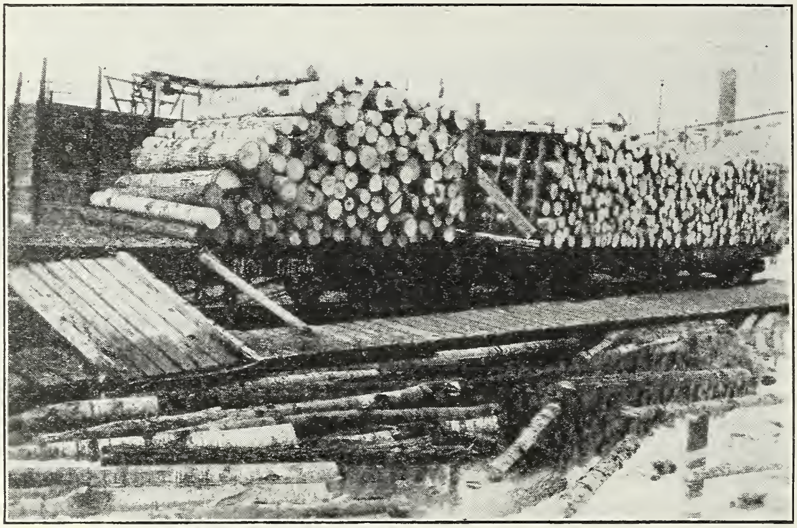

FIGURE 3.—Unloading 8-foot logs from railway cars to the log pond at a dimension-stock plant.

hold logs for several days' run since delays in log delivery due to unfavorable weather or other causes should not be permitted to affect the mill operation. A pond of sufficient area to accommodate 130,000 board feet of logs measuring 10 inches in diameter will occupy 1 acre. It is advantageous to have fresh water flowing through the log pond so that it will not become foul (fig. 4). Means for drainage should also be provided in order that accumulations of bark and other debris may be periodically removed. For summer operation a pond serves to prevent end checking of logs and aids in the elimination of any gravel that may have become imbedded in the bark. For winter operation a pond introduces some difficulties at mills using purchased electric power since such mills have no steam available with which to keep the pond open.

[3] Machinery prices are subject to fluctuation. The 1936 prices are approximately 10 percent higher than those for 1932.

DELIVERY OF LOGS TO LOG DECK FROM POND STORAGE

Two methods of getting the logs from the storage pond into the mill are in use in the New England States. The most common method is the endless lugged chain, commonly designated as the

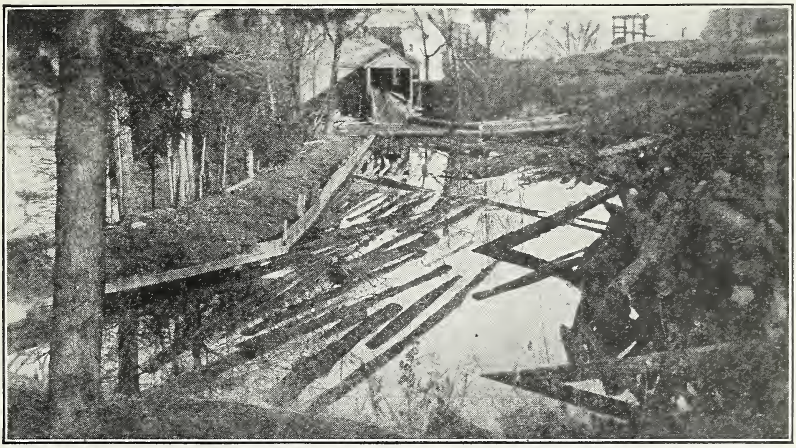

FIGURE 4.—A typical New England log pond formed by diverting a part of a river. The water can be maintained fresh and at a constant level.

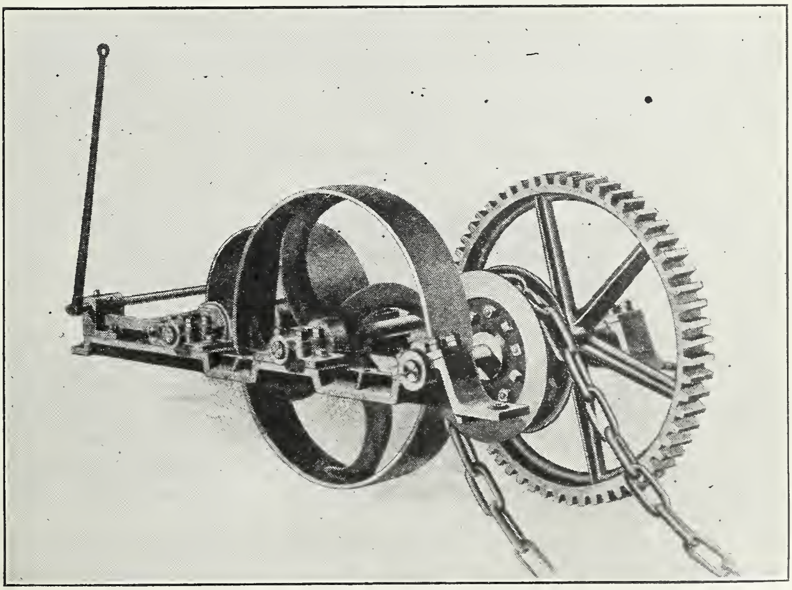

FIGURE 5.—Endless-chain log haul.

"jack chain", traveling in an inclined U-shaped conveyor trough, the lower end being in the water to receive the logs and the upper end entering the mill at the log deck. Logs are fed to the chain by a man stationed at the pond. He also keeps the logs in the pond

arranged so that there will be no interruption in the flow of logs to the chain. The movement of the chain is controlled by a man on the log deck.

The second method of bringing logs from the pond into the sawmill is by means of an endless, unlugged chain that travels in a V-shaped trough. A chain is thrown about one end of a log at the pond and then hooked to the endless traveling chain. A man at the log deck starts and stops the chain. This method is cumbersome and laborious (fig. 5).

DELIVERY OF LOGS TO LOG DECK FROM DRY STORAGE

Delivery of logs from dry storage to the log deck is ordinarily accomplished in the New England States by rolling the logs down skidways from conveniently located log piles or if the log deck is at some height above the general level of the ground a chain conveyor is used. The logs or bolts are either rolled into the conveyor or skidded in by horses.

Another method commonly employed is a narrow-gage steel track laid on an incline from the ground to the log deck, up which loaded cars are hauled by a steel cable pulled by power located at the head of the log deck.

The choice of method of getting the logs into the mill depends largely on the lay of the land. If the site permits, the log deck should be slightly below or at least on a level with the skidway outside the mill.

LOG CUT-OFF SAWING

The extent to which a log cut-off saw is used depends largely on the kind of logs with which the sawmill is supplied. If logs are long, crooked, and somewhat defective considerable cutting is necessary. Small logs cost appreciably more to cut per thousand board feet of product than do large ones, and when logs are crooked, together with being small, the cutting cost is out of proportion to the value of the product. Moreover, long, crooked boards are expensive to handle in that they are wasteful of space in piles, wagons, trucks, and dry kilns. Where the final product is dimension stock it is good practice to cut crooked logs into straight sections before they reach the head saw.

The dragsaw (fig. 6), and the circular saw are the types of log cut-off saws commonly used in New England. A third type recently developed is a motorized chain saw. It has not yet found its way generally into sawmills although it is used successfully in timber and pole yards for trimming poles and cutting timbers to length.

For most small mills the dragsaw is the most practical. It requires less attention than a circular saw although it may not work so fast.

HEAD SAW

The choice of a head saw depends upon the type of logs available and the form of dimension stock that is to be the major output of the cut-up plant. Where the logs are small in size and rather poorly formed the short-log type of head saw and carriage will serve the needs more satisfactorily than equipment designed for long, big logs. There are a number of satisfactory makes of such head saws

on the market. Some are equipped with carriages designed for rapid handling of bolts as short as 2 feet (fig. 7). However, since there is some demand for dimension stock 6 feet and even 8 feet long, it is preferable to have carriages that will effectively handle logs up to 8 feet in length. The cable drive is still standard and satisfactory for short-log carriages.

Within the last few years band saws have been developed for small sawmill use, but their general adoption has been slow. They have some distinct advantages—notably, narrow saw kerf, speed, accuracy—but they also have some disadvantages, which for the small operator are serious. Chief among these are high initial cost of machine, high installation cost, and need of experts to keep the machine and saws in proper operating condition. For sawmills that employ millwrights and skilled mechanics the possibilities of the short-log band bolters (fig. 8) should be investigated.

A specialized type of gang saw is a third possibility for the sawmill that is to cut small logs preparatory to their manufacture into

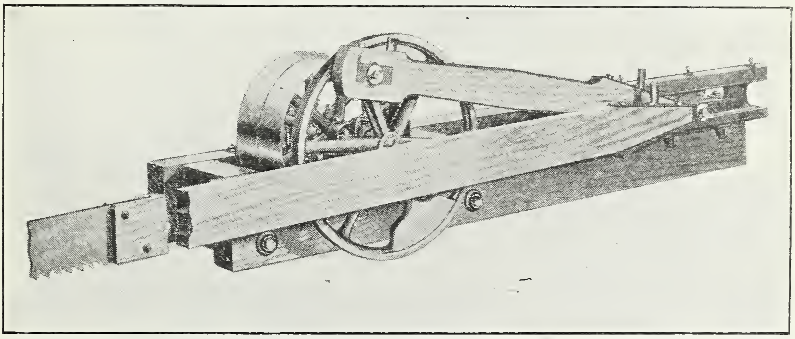

FIGURE 6.—A modern dragsaw.

dimension stock. In recent years a number of these have been installed, but as yet it is impossible to get unanimity of opinion with respect to their practicability for use in small sawmills. They are expensive and require unusually stable foundations. Points in their favor are the ability to cut small, low-grade logs accurately and rapidly. Gang saws are not new in sawmill equipment, but the recently introduced type has the outstanding feature of handling round logs instead of cants, that is, logs slabbed on two opposite sides. Regardless of how small, rough, or crooked logs may be they are held firmly in the log gangs by special dogging arrangements until they have passed through the saws.

Of the three types of head saws mentioned, the short-log carriage with a circular saw is the most suitable for ordinary small-mill, small-log use. Such a circular saw, often designated a "short log bolter", requires with electric power a motor of 25 horsepower. Operated with a steam engine the horsepower rating may be slightly less and with a gasoline engine it may be 50 percent more. A common fault with small sawmills is lack of power to carry peak loads. Such loads come frequently with large logs and much time is lost and inaccurate work performed while waiting for the saw to pick up speed. To avoid the annoyance and expense of delays caused by

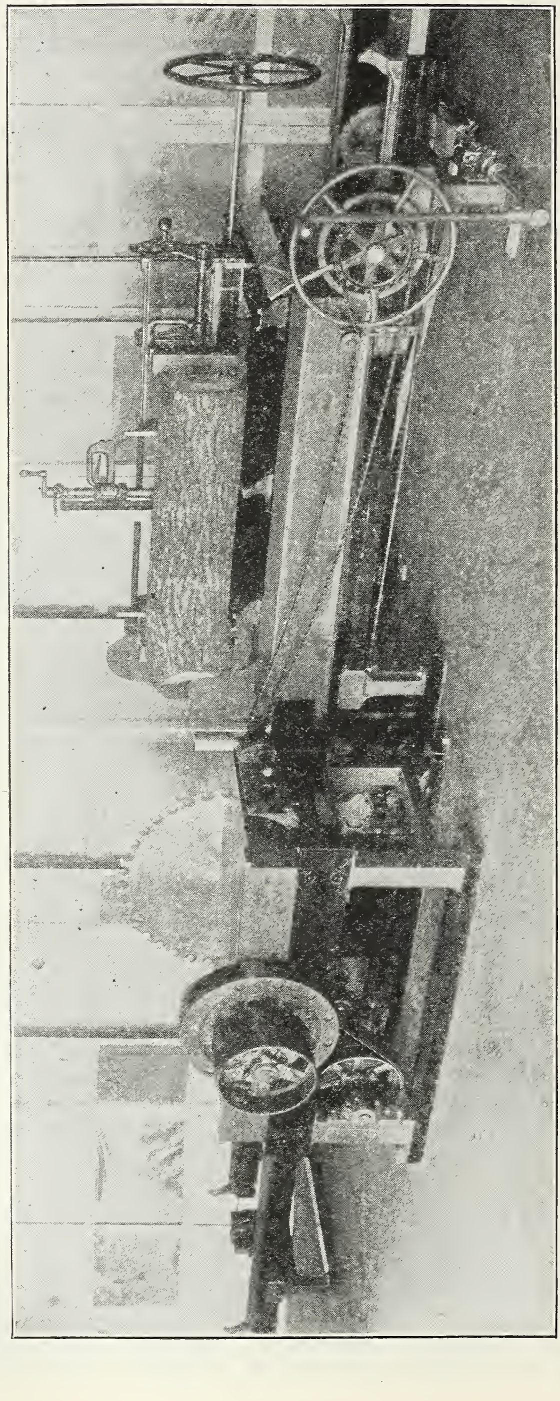

FIGURE 7.—A modern short-log head saw.

overloads a sawmill should have a reserve power about 50 percent in excess of the amount needed for the average load.

TRIM SAW

Lumber to be kiln- or air-dried before going to the cut-up plant is more easily and economically handled if ragged ends are cut off at the sawmill. Any crude, improvised trimmer located along the rolls back of the head saw will serve the purpose for the occasional boards to be trimmed. The tail sawyer can toss aside the

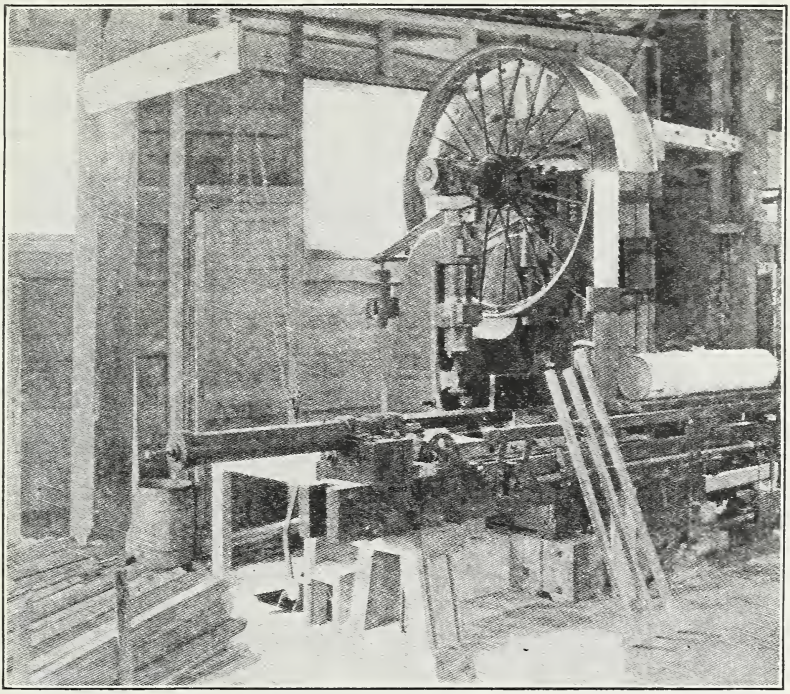

FIGURE 8.—A short-log band saw.

boards to be trimmed and another member of the crew can do the trimming whenever interruptions in mill operation permit absence from his regular job.

LIVE ROLLS

It is a comparatively simple and inexpensive job to motorize the roll conveyor back of the head saw. Live rolls have a distinct time-saving advantage in that they allow boards to travel to their proper destination and slabs and waste portions of logs to travel to the slasher or to the rear end of the sawmill without any handling.

SLASHER

A 24-inch circular swing saw will serve the purpose for slashing. Waste may be cut to stove length, 16 inches, or to 4-foot lengths

depending upon the local demands. Suitable direct motor-driven swing saws are available. Waste may be cut uniformly to 4-foot lengths, dried in this form, and subsequently at the time of marketing cut to 16-inch lengths with a gasoline-powered saw or cheaper power if it be available.

EDGER

For the operator who wishes to be equipped to market some square-edged lumber, there are inexpensive edgers satisfactory for light edging. If there are only occasional boards to be edged or an occasional edging job the work may be done on ripsaws at the cut-up plant.

SAWMILL AND EQUIPMENT COSTS

The total cost of a small mill and equipment required for production of rough lumber necessary for the manufacture of 8,000 board feet of dimension stock daily is about $8,000. Items of cost based on 1932 prices [4] are as follows:

Sawmill building	$2,800
Circular mill	1,500
Log cut-off saw	250
Trim saw	200
Slasher	150
Edger	400
Pond	300
Log conveyor	600
Air-drying yard	1,800
Total	8,000

The above estimate is based on the assumption that all machines are equipped with individual motors and that power will be purchased.

DIMENSION-STOCK PLANT EQUIPMENT

The equipment required for a dimension-stock plant of 8,000 board feet daily capacity when operated either as an integral part of a sawmill or as a concentration plant for outlying feeder sawmills consists of 2 lumber lifts, 2 cut-off saws, 2 ripsaws, 1 glue jointer with necessary adjuncts, 1 patternmaker's lathe, 1 hand jointer, 1 cabinet planer, 1 combination scroll and resaw, 1 single drum sander, 1 belt sander, 1 shaper, 1 bench variety saw, 20 factory trucks, 1 power transfer car, 1 wire-tying or steel-banding machine, 1 bundling rack, and 1 dust-and-shavings-collector system. This equipment will turn out dimension stock machined to satisfy most of the requirements of the average wood-fabrication plant.

The equipment can be housed in a one-story building 60 feet wide by 80 feet long. This size of building also provides space for wash, coat, and toilet rooms. An office to accommodate the officials of the sawmill and cut-up plant and their clerical force should be detached from this building in order to eliminate factory noise, dust, and glue odors.

[4] See footnote 3, p. 8.

A power plant and dry kilns are required in addition to the foregoing structures if the stock is to be kiln-dried. The power plant may be housed in an addition to the cut-up plant or may be entirely separated from it. If electric power can be purchased at reasonable cost it may be preferable to steam power developed at the mill. The power plant at the mill would then be used exclusively for the development of steam for heating the shop and running the dry kilns described under the section on seasoning (p. 45).

The total cost of the concentration plant and equipment described on the following pages amounts to approximately $57,000 at 1932 prices.

LUMBER LIFT

In large measure the cut-off saws regulate the output of the dimension-stock plant; hence it is advisable to speed production by the installation of lumber lifts (fig. 9). The lumber lift should

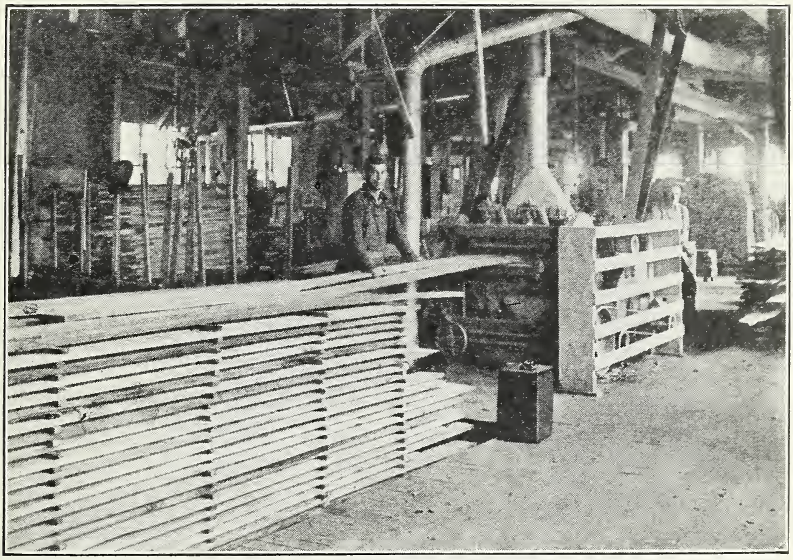

FIGURE 9.—A modern lumber lift serving a planer.

permit the truck containing the stock to be lowered until the top of the load is at the same height as the top of the cut-off saw table. As the cut-off sawyer removes boards from the truck it is elevated to saw-table height either automatically or by push-button control.

The advantages of lumber lifts are readily apparent. In common practice lumber is brought to the cut-off saw by laborious and expensive stages. If coming from a kiln the lumber is frequently handled three or four times before it reaches the cut-off saws. When finally piled for the sawyer it often forms an obstruction on the shop floor and is in such a position that it cannot be handled with the least amount of labor.

CUT-OFF SAWS

The manufacture of 8,000 board feet of dimension stock daily requires the use of two cut-off saws in order to balance machine operation. Straight-line saws are a notable advance over the swing-saw type of machines. Their use is recommended for dimension-stock manufacture because they are easier and safer to operate and do more accurate work than the swing-saw type (fig. 10).

RIPSAWS

From the crude hand-feed type no longer used in modern woodworking plants, ripsaws of the self-feed, straight-line type have been developed (fig. 11) and new cutting quality standards created thereby. Modern methods demand sustained high production combined with

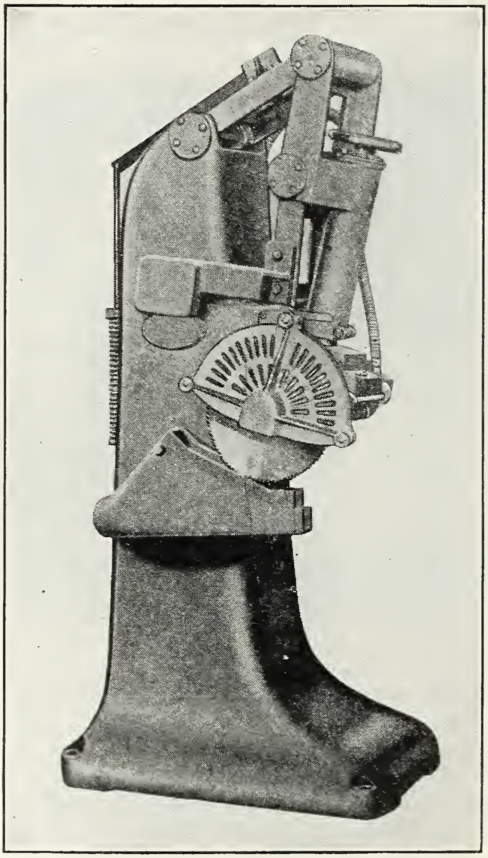

FIGURE 10.—A modern cut-off saw.

a high degree of precision, both of which are assured with the ripsaws developed in recent years. Most of them are made to run at three optional speeds—low, medium, and high, the choice depending

upon the type of stock being cut and other factors. Speeds vary from 30 feet per minute to a maximum of 180 feet per minute. Most of the modern ripsaws cut so accurately and smoothly that the surfaces are frequently glued without jointing.

Ripsaws are available in two types: (1) The undercutting type in which the saw arbor is below the saw table and the saw projects through the table, and (2) the overcutting type in which the saw arbor is above the table and the saw cuts from above and down to the table level. Some ripsaws are built with a motorized arbor and others are designed to be either direct motor driven or belt driven from motor or countershaft. The tables are heavy and will remain true. Guides are rapidly adjustable for making cuttings of differ-

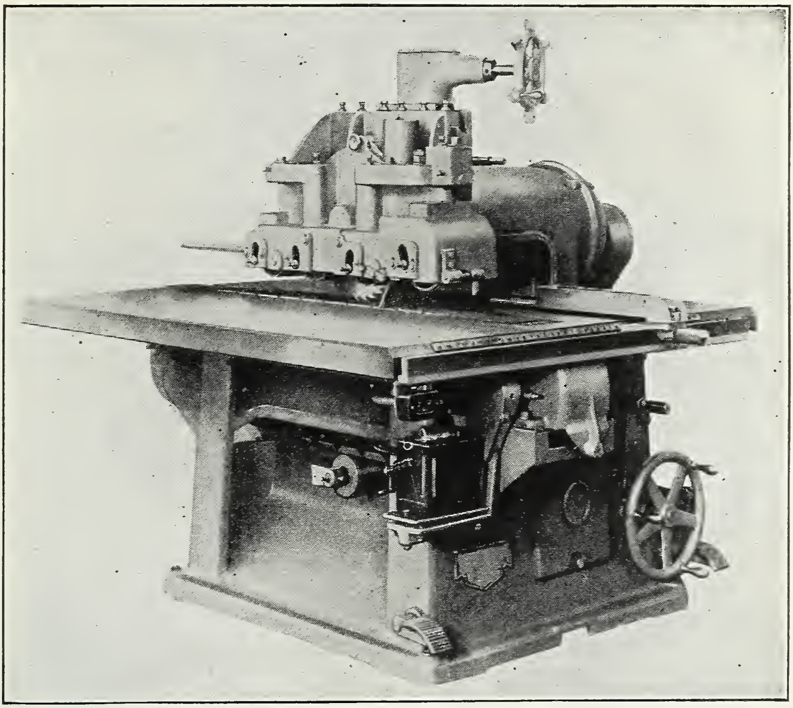

FIGURE 11.—A modern self-feed, straight-line type ripsaw.

ent widths. Between the feed-chain blocks and the press rolls, stock is held firmly and passes through the saw precisely in the position in which it is fed into the saw.

An important point to bear in mind in considering ripsaws for cutting dimension stock is the fact that, with the undercutting type, it is possible to saw stock as short as 4 inches, whereas the overcutting type handles stock under 8 inches long at considerable disadvantage. On the other hand, the overcutting type simplifies the problem of sawdust disposal and it makes possible a more positive feed.

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Straight-line ripsaws require motors of 10 to 15 horsepower, depending on the size of machines, the thickness of stock to be ripped, and the production speed for which the saw must be prepared. Thick stock and high speed create heavy demands on power.

Floor space required for a typical ripsaw machine is about 5 feet square. The weight of a machine is between 2 and 2½ tons.

There are effective ripsaws of a light-duty type that may satisfy some operators better than the heavy-duty type. They are worth consideration. It should be borne in mind, however, that accurate ripsaw work is absolutely essential and that it is false economy to try to save money on the first cost of the machine at the sacrifice of quality of work.

GLUE JOINTER

No dimension-stock plant can meet general requirements without complete gluing equipment. Four essentials are glue jointer, glue heaters or mixers, glue spreaders, and glue clamps.

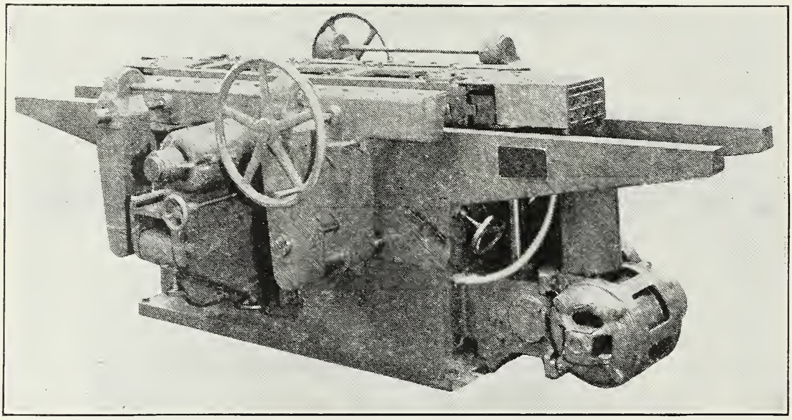

FIGURE 12.—A modern glue jointer.

Various types of glue jointers are available (fig. 12). One of the smallest suitable for a dimension-stock plant with moderate output will joint stock up to 4½ inches thick, one-half inch and up in width, and 6 inches and up in length. It will also edge mold. It has a chain feed and may be operated at any one of four speeds, ranging from 27 to 80 feet per minute. The motors are of 5-horsepower drive and the spindles rotate at 7,200 revolutions per minute. It weighs about 2½ tons and requires a floor space 5 feet wide by 9 feet long.

GLUE MIXERS AND HEATERS

Vegetable (starch) glue is prepared by mixing dry glue with water and stirring during heating until of a uniform consistency. On account of the high viscosity of the mixture, mechanical stirring is a practical necessity. Casein glues must not be heated at any stage of mixing. A dough mixer of the type illustrated in figure 13

is one of the several machines which may be used satisfactorily for mixing casein glue. Vegetable and casein glues are used cold.

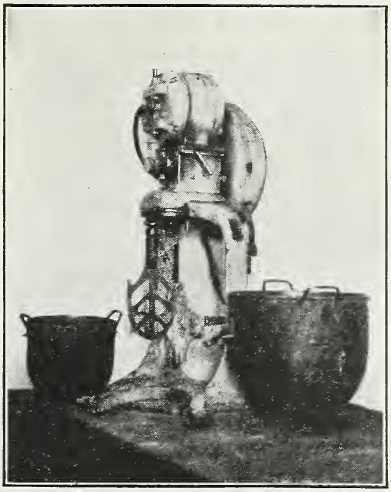

FIGURE 13.—Dough-type mixer for casein glue.

Animal glues are mixed with water, then melted, and used warm. The temperature of the glue is difficult to control at the workbench

FIGURE 14.—Two types of electric gluepots with automatic temperature control for animal glue.

without some automatic temperature regulator. Electrical gluepots that furnish a moderate, steady supply of heat or that are equipped with a thermostatic control are now in use (fig. 14).

GLUE SPREADERS

Glue spreaders (fig. 15) of the hand-feed, roll type, satisfactory for gluing edge and narrow-face stock are available. A machine of this class will handle the face of stock up to 20 inches wide. The rolls are power driven and revolve with the lower portion submerged in a tank containing glue mixture. A constant thickness of glue is maintained on the rolls by means of a stationary scraper.

The floor space required for the glue spreader shown in figure 15 is about 1 foot wide by 2½ feet long.

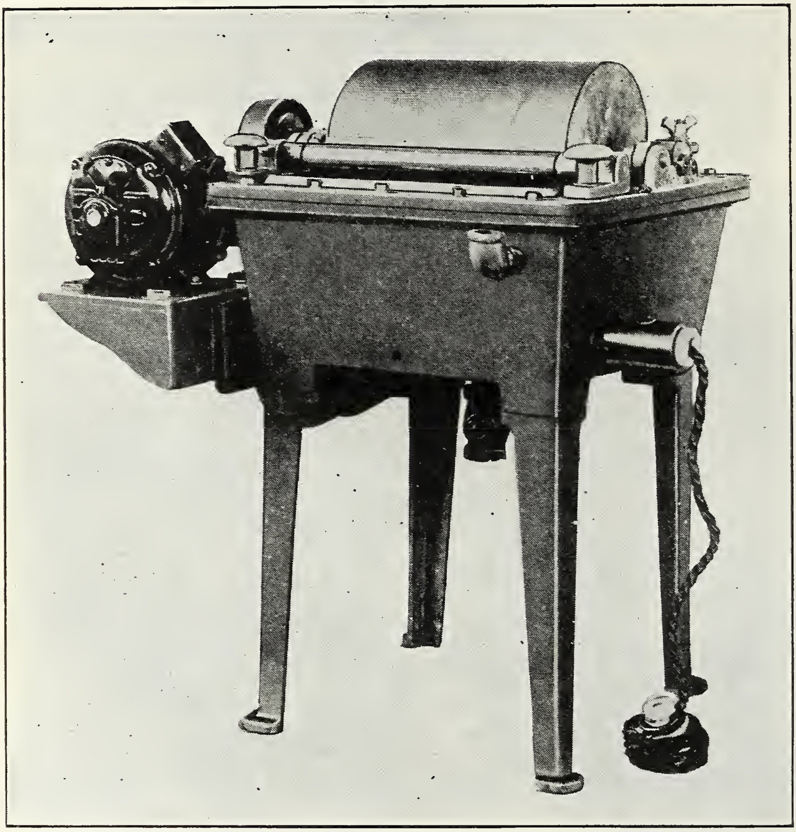

FIGURE 15.—A modern glue spreader.

GLUE CLAMPS

Glue clamps, mounted on a carrier, afford a convenient and efficient method of clamping stock. The glue clamps and carriers (fig. 16) are fairly standard in design. A suitable type for a dimension-stock plant with a daily output of 8,000 board feet of finished product has a capacity of 20 glue panels, which may contain stock up to 6 feet long. In a plant of this capacity only a small proportion

of the dimension stock will require gluing, therefore the small carrier gives ample capacity. A 3-horsepower motor is required for its operation. A glue-clamp carrier of this type weighs about 4½ tons and requires a floor space about 10 feet wide by 11 feet long and an 11-foot ceiling.

The clamp carrier should be enclosed in a room apart from the rest of the shop in order to maintain proper temperatures for gluing and setting of glue. Such a room should be about 15 feet square.

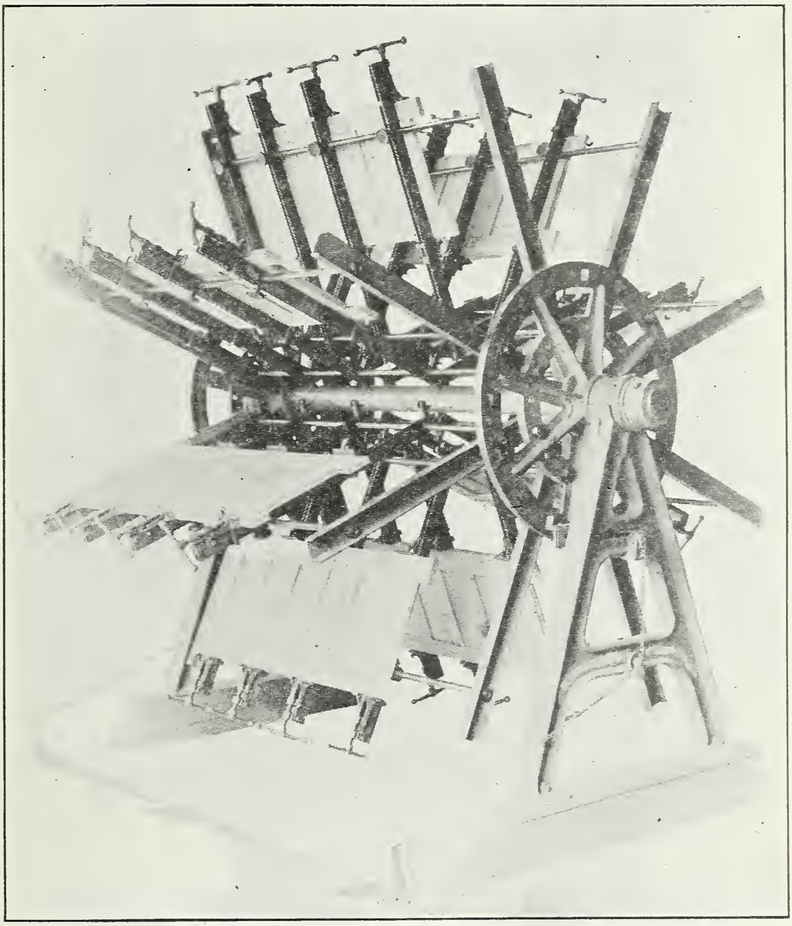

FIGURE 16.—A modern glue-clamp carrier.

PATTERNMAKER'S LATHE

A simple lathe (fig. 17) of small capacity is of great convenience in a small dimension-stock shop. Jobs requiring large capacity of special lathes can be performed more economically by factories specializing in turning. A suitable small lathe is one driven by a ½-horsepower motor. It will handle stock 24 inches long and swing

12 inches over the bed. It may be used on a bench or on a floor stand.

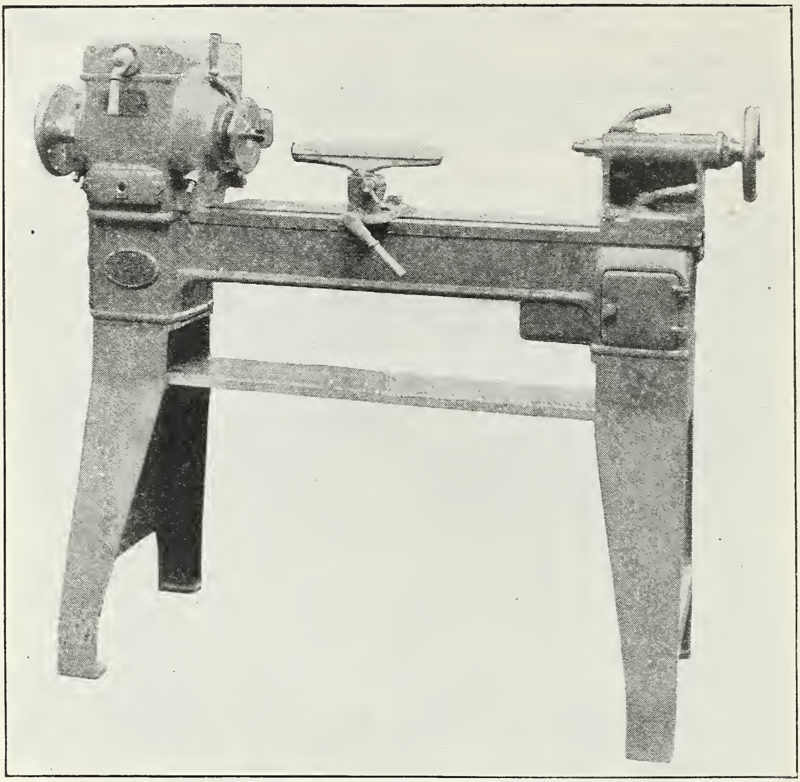

FIGURE 17.—A patternmaker's lathe suitable for dimension-stock manufacture.

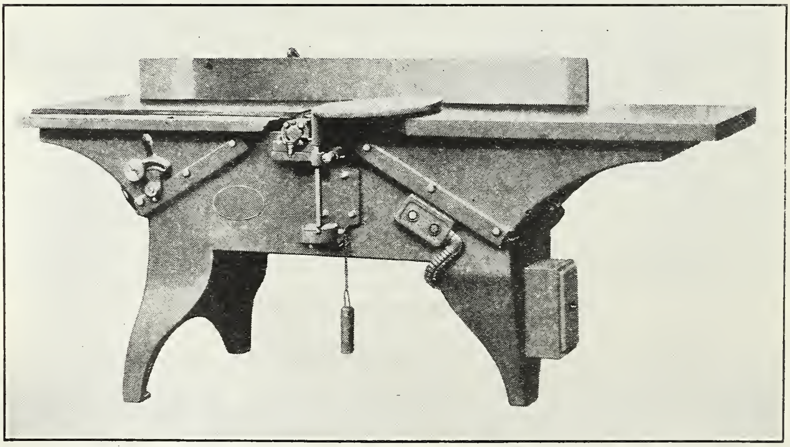

FIGURE 18.—A hand jointer is essential in a modern dimension-stock plant.

HAND JOINTER

A hand jointer (fig. 18) is practically indispensable in a modern dimension-stock plant. There are innumerable large and small jobs

where the hand jointer can perform effectively and economically. It is a relatively inexpensive piece of equipment, simple to maintain, and its demand on floor space is moderate. There are many hand jointers available, so there is little difficulty in satisfying personal preference of operators.

A jointer that is suitable for a dimension-stock plant of 8,000 board feet capacity daily has a cutter head 16 inches wide set in a table 84 inches long. The lips between which the cutter head revolves may be separated horizontally to a distance of 7 inches. The vertical adjustment of the table controls the depth of cut of the knives in the

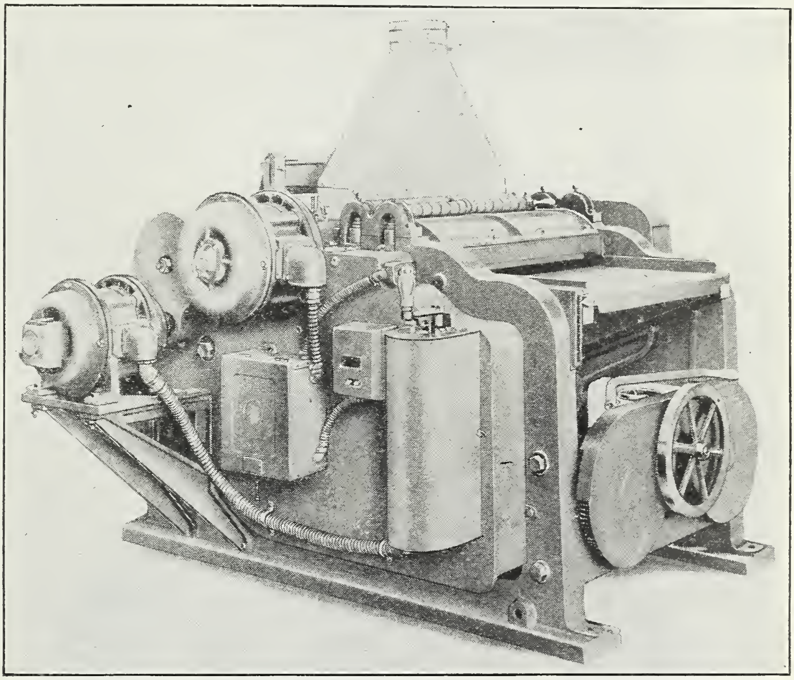

FIGURE 19.—A cabinet planer suitable for a modern dimension-stock plant.

cutter head. This jointer weighs approximately 1 ton and requires a motor of about 5 horsepower and a floor space about 4½ by 7 feet.

CABINET PLANER

A modern dimension-stock plant cannot operate without a planer (fig. 19). For ordinary jobs a single surfacer of which there are many types available will render satisfactory service. This type is relatively inexpensive and is more easily kept in adjustment and good working condition than the double surfacer types.

A single surfacer of a make in common use requires a motor of about 10 horsepower. It will handle dimension stock as short as 12 inches and up to 7 inches thick, although if pieces are kept butted against each other as they pass through they will span the 2½-inch throat in lengths as short as about 3 inches. Stock may be surfaced at the rate of 45 feet per minute. Machines are available in widths from 26 to 64 inches. Except for wide panel work, the 30-inch width

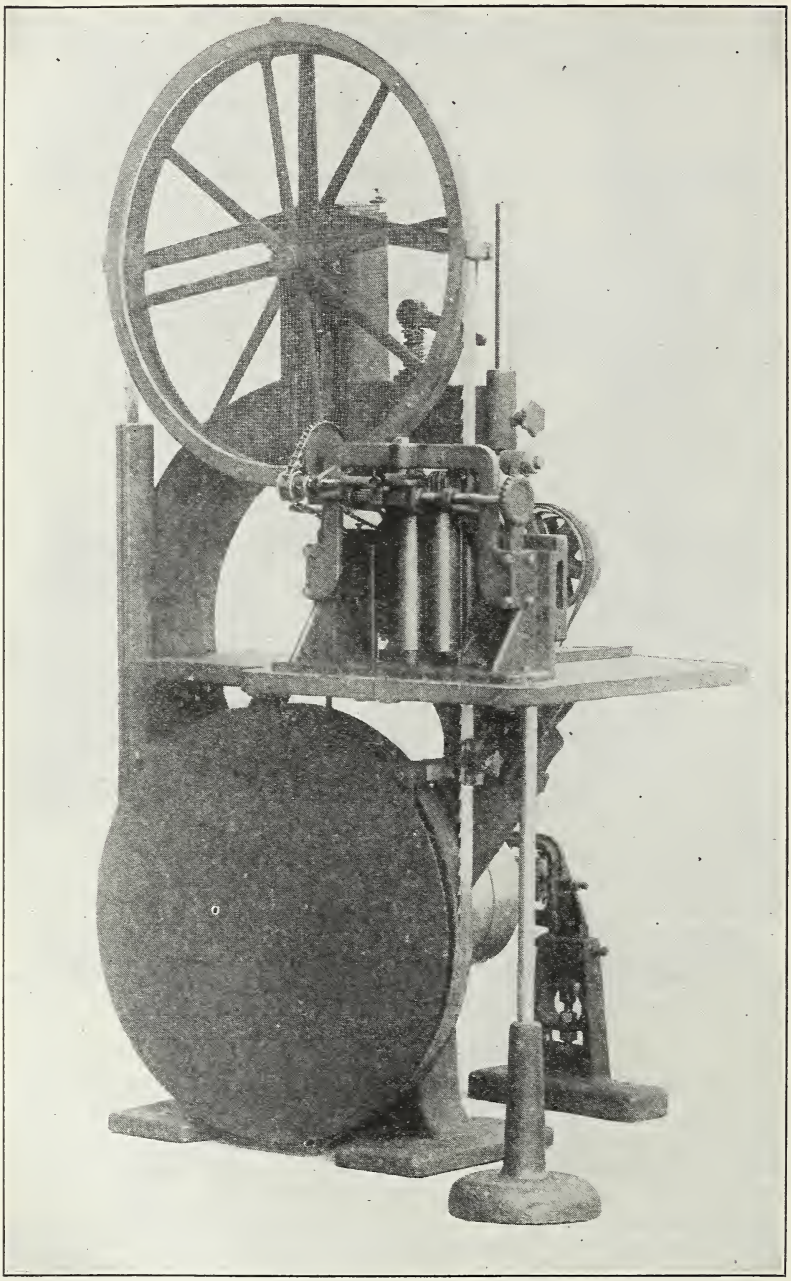

FIGURE 20.—A combination scroll and resaw suitable for the manufacture of dimension stock.

is convenient and economical for a small plant. A floor space of about 7 by 9 feet is required to accommodate the planer. Its weight is about 4½ tons.

COMBINATION SCROLL AND RESAW

There is considerable need for a scroll saw in a dimension-stock plant, but only occasional demand for a resaw. Ordinarily maximum satisfaction can be had from a machine designed for some one type of work, but in view of the fact that the combined scroll and resawing normally would not require the full-time use of one machine it is advisable to install a combination scroll and resaw (fig. 20). Such machines are readily available, and, although they are not practical for heavy resawing, they will perform satisfactorily for the light jobs of the kind that arise in dimension-stock plants.

One of the combination band scroll and resaw machines now in use in a dimension-stock plant occupies a floor space of 3½ by 5 feet and weighs about 1 ton. It requires a motor of 7 horsepower. The distance from the guide to the table is 12½ inches, and the distance from the saw to the columns is 36 inches. The maximum size of stock that can be sawed on this machine is 4 inches thick by 12 inches wide, and it may be run at 20, 30, and 40 feet per minute. The band-saw wheels are 36 inches in diameter and they will carry a saw up to 2 inches wide. The conversion of the machine from a scroll saw to a resaw is accomplished by the attachment of feed rolls.

DRUM SANDER

From 25 to 30 percent of the output of a dimension-stock plant ordinarily requires sanding. A single-drum sander (fig. 21) is more

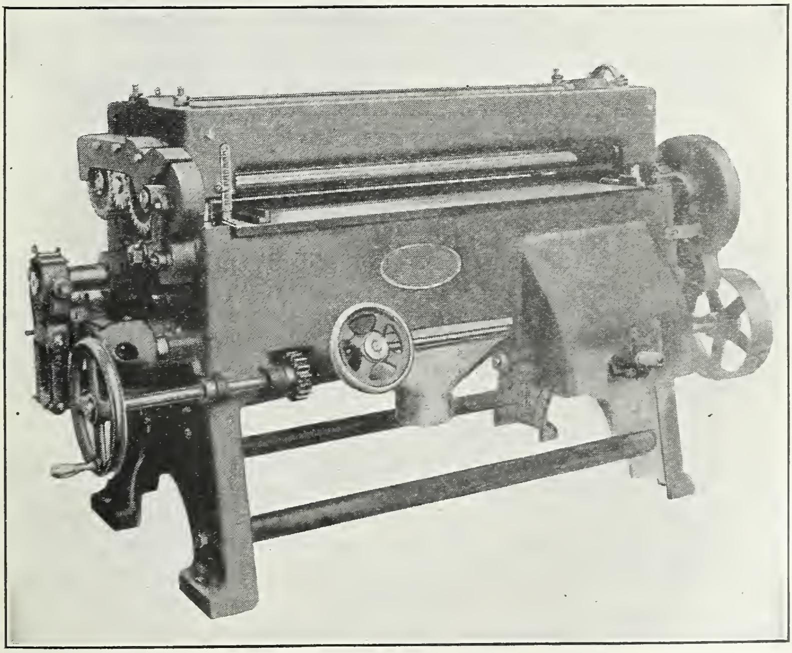

FIGURE 21.—A single-drum sander is suitable for modern dimension-stock manufacture.

satisfactory than a triple- or even a double-drum sander. One of the many suitable single-drum sanders available is equipped with a drum 16 inches in diameter with optional lengths of 24, 28, or 30 inches. The power requirement for this sander is 5 to 10 horsepower and the floor space occupied is 4 feet long by about 6 feet wide.

BELT SANDER

Of the various types of belt sanders (fig. 22) available to woodworking shops the variety type is the most practical for the small shop since it will perform effectively several types of work. For quantity and quality production of one particular type of product a sander designed specifically for such work will give more satisfactory service.

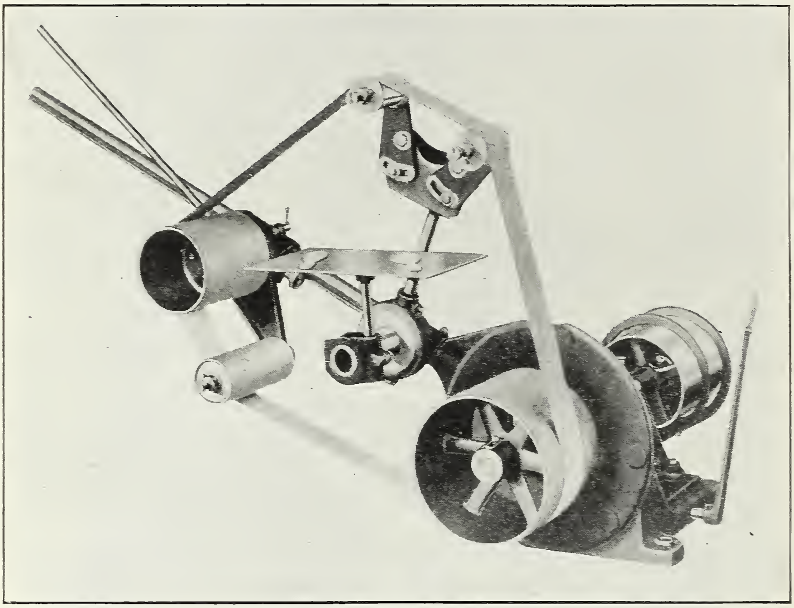

FIGURE 22.—A modern belt sander.

Belt sanders are relatively inexpensive and will quickly return their cost when sanding of irregular or patterned stock is an essential step in the manufacturing operation. A 2-horsepower motor furnishes ample power. The machine complete weighs slightly over one-half ton and occupies a floor space of about 4 by 8 feet. Belts 12 to 15 feet long may be used in widths up to about 12 inches.

SHAPER

The types, makes, and sizes of shapers are numerous. One of the smaller, motor-driven, single reversible spindle machines (fig. 23) will serve the needs of a dimension-stock plant. Such a machine weighs about three-fourths ton and requires a floor space about 2½ by 4 feet. It is driven by a high-speed motor of about 5 horsepower.

BENCH SAW

A bench saw is frequently useful in a dimension-stock plant for performing small crosscutting jobs that not only can be done more

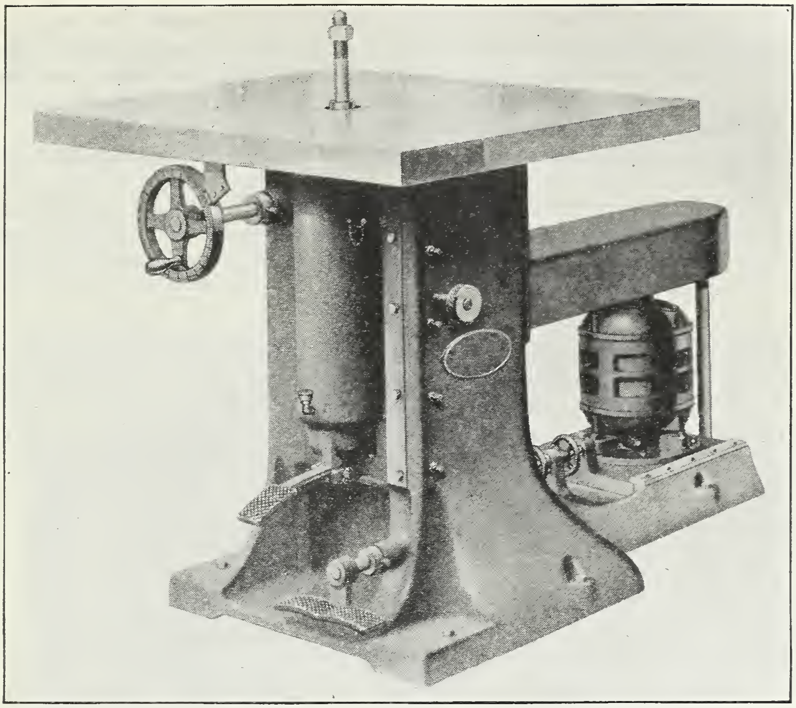

FIGURE 23.—A small motor-driven shaper suitable for the needs of a modern dimension stock plant.

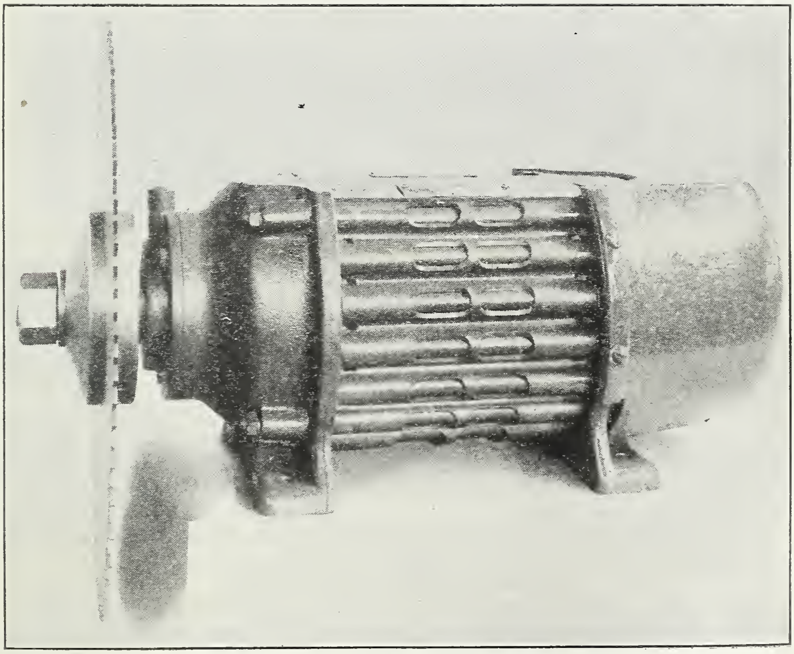

FIGURE 24.—A saw-arbor motor.

easily and with less power consumption on a small saw than on regular straight-line cut-off saws, but can be done at times when heavier and more important jobs are occupying the large machines. One bench saw now on the market has a motorized arbor and the entire unit can be screwed directly to the saw table (fig. 24). A motor of 1½ horsepower will perform the work expected of this machine.

Still another recent development is a straight-line cut-off saw designed for mounting on any convenient bench. It requires small space. Its maximum cutting capacity is stock 2 by 24 inches in size.

FACTORY TRUCKS

Factory trucks (fig. 25) are an important item in the equipment of a dimension-stock plant. They are in constant use and save much handling. There should be enough of them to make frequent transfers of stock from truck to truck unnecessary. A dimension-stock plant of 8,000 board feet daily capacity should have about 20 trucks.

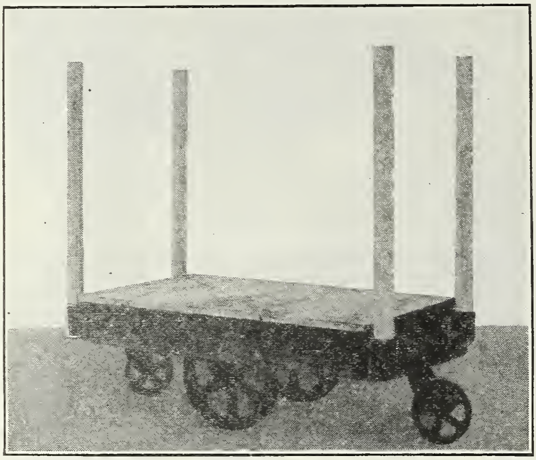

FIGURE 25.—Factory trucks are essential equipment of a modern dimension-stock plant.

A desirable type that is readily available has a pair of 16-inch wheels set on an axle running under the middle of the truck platform. Each end of the platform has a single 6-inch wheel with caster attachment to the platform frame. The truck thus turns readily end for end in its own length and can be moved about between machines and other trucks with minimum confusion.

Corner stakes set firmly in steel pockets form another desirable feature of this truck. Ordinarily loads of short stock are unstable, and the support of the stakes is essential. When not needed the stakes may be removed.

These trucks are 16 to 18 inches high, about 2 feet wide, and 4 to 5 feet long.

POWER TRANSFER EQUIPMENT

One of the most laborious tasks at a dimension-stock plant is transferring loaded kiln trucks without power equipment. The usual

method of moving loaded kiln trucks is to assemble eight or more men from their regular jobs and after much pushing, pulling, and prying finally force the kiln truck to the point desired. It is a slow, inefficient, unsatisfactory, and expensive process.

It is safe to say that preparing to go out on a truck-moving job, the actual time spent on the job, and getting back and settled on the regular job again, causes a total interruption of at least 15 minutes for each man called. For moving one kiln truck each day an electric- or gasoline-power car (fig. 26) would cost about 75 cents more per day than moving by hand. Where there are two or more kiln trucks to be moved each day as is the case at a dimension-stock plant of 8,000 board feet daily capacity the cost of moving trucks by a power car is considerably less than by hand, for the large investment in the car and depreciation items remain practically the same regardless of the number of trucks moved, whereas with trucks moved by man-power the labor item is doubled for two trucks, tripled for three trucks, and so on.

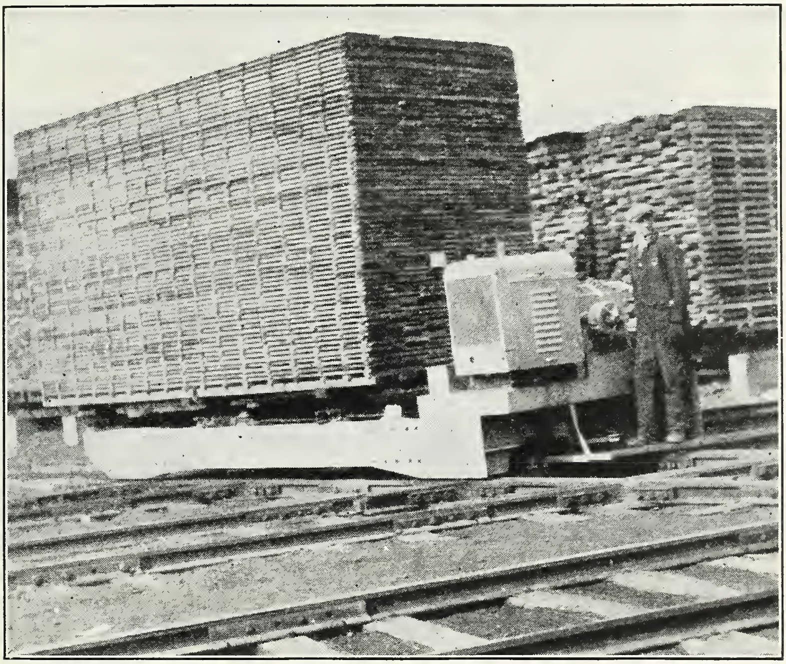

FIGURE 26.—A power transfer car.

Less expensive equipment for moving kiln trucks is available in so-called car pullers. At some plants they are preferable to power cars because of lower initial cost. Although not so flexible as the power car, they are nevertheless a valuable convenience.

WIRE-TYING OR STEEL-BANDING MACHINE

Bundling of dimension stock with wire or steel bands has been developed to a stage where there are tying machines and devices of various types on the market, some of which are extremely simple and

some of which are complicated. The choice of bundling equipment is a problem that merits considerable study, but fortunately manufacturers of wire-tying equipment are in a position to render valuable assistance.

Figure 27 illustrates one of several types of machines that make very effective ties. Tension on the band around the bundle is obtained mechanically.

The simplest device now used for wire tying is a metal hand grip about 6 inches long through which a wire is threaded. The interior of the grip contains a clutch arrangement that can be manipulated so as to permit the wire to slip whenever the operator desires. With this device, tension on the wire is accomplished entirely by hand; hence the quality of the tie and the compactness of the bundle depend entirely upon the operator. The device simply furnishes a means by which the wire can be gripped by the workman as he pulls

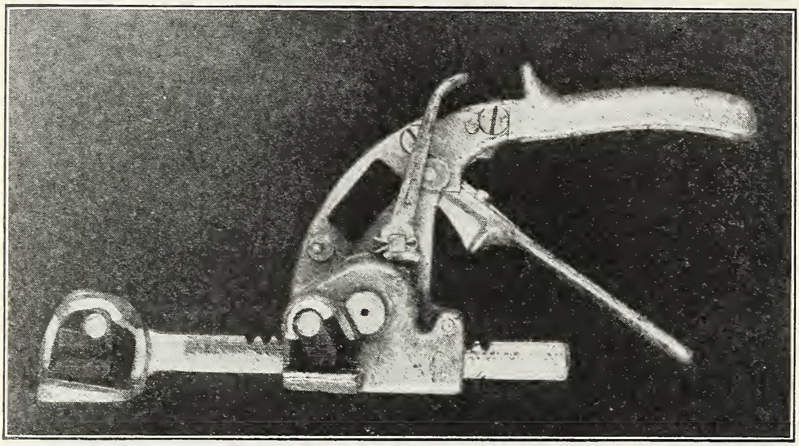

FIGURE 27.—A modern steel-band stretcher.

it taut about the bundle, ties it, and breaks it at a kink close to the tie.

BUNDLING RACK

Sorting of dimension stock is accomplished by means of various rack arrangements. Pieces of like size are placed in pigeonholes or compartments until the number required for bundles of different sizes are brought together, after which they are either tied into bundles in place in the racks, or they are removed to some other point and the bundling completed there. Satisfactory bundling racks can be constructed at the shop to suit the particular requirements of the cut-up plant. Figure 28 illustrates one rack arrangement designed for sorting dry dimension stock where the tying is done before the bundles are removed from the rack. This arrangement has the advantages of small initial outlay and no subsequent upkeep costs. Its capacity, however, is limited to but a few cutting sizes. There are similar racks where the compartments are arranged vertically (fig. 29). The vertical arrangement necessitates tying the bundles after they are removed from the rack.

The compartments are built a few inches short of the length of stock they are designed to accommodate in order to facilitate removal of the pieces for bundling. For instance, a compartment designed for 30-inch stock may be only 24 inches deep, 6 inches of the stock projecting to enable the operator to grasp it more readily for removal.

Compartments in a vertical rack can extend from about 18 inches above the floor to as high as a man can conveniently reach—about 5 feet. This type of rack is, therefore, far more economical of floor space than a horizontal rack.

Automatic sorters are only partially successful because they sort only for length of one class of stock. Hence, they operate satisfactorily when the dimension stock consists entirely of 1- or 2-inch

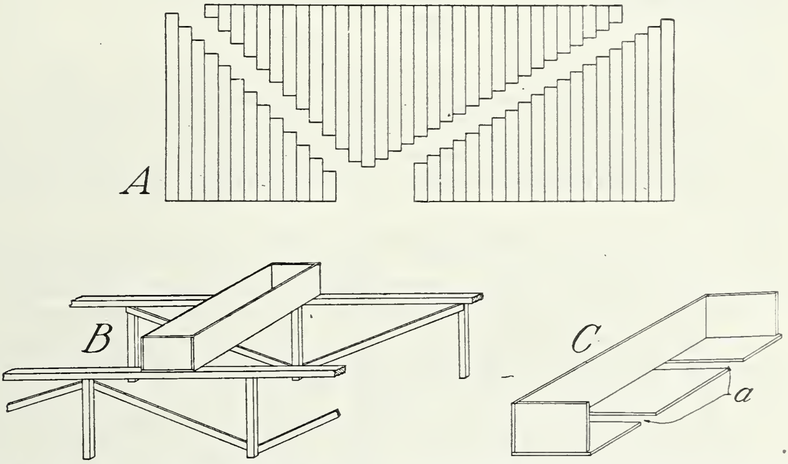

FIGURE 28.—A horizontal sorting rack: *A*, Diagrammatical sketch of the rack; *B*, detail of the rack; *C*, detail of sorting box with one side removed showing at *a* opening in bottom for passing binding material around bundle.

squares, or some other size, but when different sizes of squares and various widths of flat stock are cut simultaneously, as is usual where the raw material is logs, they must be supplemented by hand sorting.

DUST- AND SHAVINGS-COLLECTOR SYSTEM

A dust-collector system in a dimension-stock plant is essential for serving the cut-off saws, ripsaws, glue jointer, bench saw, lathe, shaper, scroll saw, hand jointer, belt sander, drum sander, and planer. Dust and shavings must be disposed of effectively in order to enable machines to give maximum service. Dust-clogged motors tend to develop temperatures against which they are not protected. Collector systems are installed according to the advice and under the direction of engineers trained in this type of work.

DIMENSION-STOCK PLANT EQUIPMENT COSTS

The total cost f. o. b. the factory of the equipment required for a dimension-stock plant of 8,000 board feet capacity at 1932 prices[5] is as follows:

2 lumber lifts	$4,000
2 cut-off saws	1,200
2 ripsaws	4,100
1 glue jointer	2,000
1 glue heater and mixer	25
1 glue spreader	250
1 glue clamp carrier	900
1 patternmaker's lathe	350
1 hand jointer	500
1 cabinet planer	3,500
1 combination scroll and resaw	900
1 single-drum sander	2,500
1 belt sander	450
1 shaper	750
1 bench variety saw	$700
20 factory trucks	1,500
1 power transfer car	2,500
1 wire-tying or steel-banding machine[6]	------
1 bundling rack	150
1 dust- and shavings-collector system	1,500
6 dry kilns (p. 46)	20,000
Service trackage (p. 47)	1,725
1 steam plant (p. 37)	2,500
1 shop—building	5,000
Total	57,000

The foregoing machinery prices apply to high-grade, improved, new equipment. Some saving in initial cost would be possible if a cheaper grade, used, or rebuilt machines were purchased. Machinery manufacturers usually have rebuilt machines that they will sell with new-machine guarantees. There are also dealers in second-hand machinery.

Aside from the equipment itemized there are numerous tools, grinders, extra saws, extra knives, and other accessories required, including possibly a sprinkler system for fire protection. No attempt has been made at a close estimate of such miscellaneous equipment.

It would be practical for some plants to eliminate certain items of equipment from the list shown here such as power transfer car, truck elevators, glue jointer, lathe, bench variety saw, shaper, belt sander, and drum sander. There still would remain equipment for producing dimension stock of the following description: (1) Air-dry or kiln-dry stock cut to rough finish sizes, (2) air-dry or kiln-dry stock cut to exact sizes and surfaced ready for sanding, (3) squares ready for turning, (4) scroll saw work, (5) glued-up panel stock, such as table-top cores, surfaced to final thickness.

OPTIONAL SHOP EQUIPMENT

Obviously it is convenient to have equipment that makes possible any kind of machine work that a dimension-stock plant may be called upon to perform. However, a small plant cannot hope to be so equipped. It must limit its variety of machines to those that are essential to filling the bulk of orders that come its way. Good, up-to-date machinery is expensive, and machinery, good or poor, much or little used, demands valuable shop-floor space. The combined cost of a machine—initial cost, interest on investment, maintenance, depreciation, insurance, taxes, floor space—is an item of rather large proportions. An operator must assure himself that a machine will pay its way, otherwise its purchase is unjustified.

[5] See footnote 3, p. 8.

[6] No initial cost item is included because bundling machines are usually obtained on a lease basis.

Among the machines that have not been included in the plan for a dimension-stock plant of 8,000 board feet daily capacity are: Jig saw, borer, dowel machine, back-knife lathe, router, equalizer or double-end trimmer, and molder. These are all desirable machines, but their practicability for a small plant is questionable. Occasionally a dowel machine might be convenient to have but dowels can

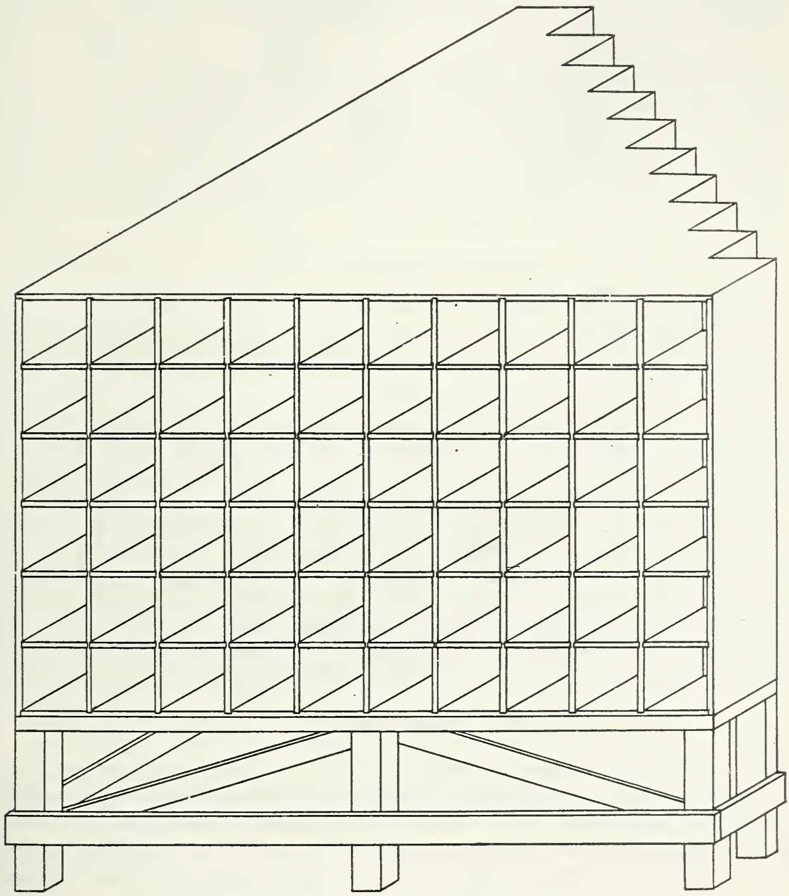

FIGURE 29.—A vertical sorting rack.

usually be purchased from a dowel plant more cheaply and of better quality than they can be made in the dimension-stock plant. Highly specialized dowel plants are equipped to make any type of dowel, dry it properly, and deliver to buyer in a short time.

A back-knife lathe is a standard piece of equipment in a completely equipped woodworking plant. However, the comment made about a dowel machine applies to it in similar manner. The expense of preparing knives is in itself an item of concern for the small plant. It is better for the small plant to decline orders that involve parts requiring back-knife lathe work or else have such parts made by a wood-turning plant for inclusion with the orders.

The comments on the dowel machine and back-knife lathe are illustrative of the kind of an analysis that must be made for each machine that may be considered in the process of deciding upon essential shop equipment.

SIZER

Where squares of dimension stock are to be shipped from the dimension-stock plant to the consuming factory in such condition that they are ready for turning it is necessary that they be sized to exact dimensions. A piece that is turned in part of its length and left square in other parts must have the squared portions in final shape before turning is done. Sizing may be done with a surfacer or it may more easily be accomplished with a molder. Here again, there is opportunity for economy if the volume of finished squares is large enough to keep a molder occupied a good part of the time and there is floor space to spare for it.

PORTABLE POWER TOOLS

Noteworthy developments have been made recently in portable power tools. Among those available are cut-off saws, ripsaws, sanders, routers, screw drivers, drills, and blowers. Such tools are motor driven yet are light enough so that they may be carried about from bench to bench with ease. Power may be taken from any convenient light socket. Handsaws equipped with ½-horsepower motors may be purchased for about $50 and drills for about $25. The other machines are in the same approximate price range.

Portable power tools open a new field for a dimension-stock plant in that they make it possible for a small plant to have at its disposal without the handicap of much investment a variety of convenient machines. They permit a range of operations heretofore limited to larger fully equipped shops. Portable power tools by no means replace heavy nonportable machines, ripsaws, or sanders but as auxiliary equipment they are well worth while.

CONVEYORS

Studies by the Forest Products Laboratory of the distribution of labor in dimension-stock plants have shown that more time is spent in handling material than is actually required to machine it. One of the problems of the plant, therefore, is to hold the handling-cost item within reasonable limits. Conveyors properly located greatly reduce handling since they take the place of a truck and a portion, at least, of the labor required to load the truck and push it to the next station or operation. A number of trucks, however, are always necessary in any shop.

Conveyors may be used either for transferring stock in process of manufacture or for transferring sawdust and other waste to the boiler room or to storage bins. Conveyors transferring stock from one operation to another in large measure exercise control over the rate of production, for stock mechanically fed to an operator obliges him to develop an effective method of maintaining the output of his operation in uniformity with that of others. Strict supervision is required in some instances in order to get the stock out of the way. Stock hastily worked may result in waste of material in trimming

out defects or in defects being left in that should have been cut out. The two faults are about equally bad.

Cut-off saw tables are available that have live rolls and automatic kick-out devices that make possible the delivery of cut-off stock to a conveyor and thence to the ripsaw or elsewhere without the employment of a man to carry off the stock after the cutting operation.

The objection to having operations in the same factory on different floor levels is very largely offset if simple conveyors are installed between floors.

Conveyors on the main floor of the cutting room are objectionable because they interfere with the free movement of men and trucks. A system of much merit is one where the waste conveyor is below the floor of the cutting room. Waste from the machines is dropped through trap doors in the floor and by means of slides or chutes it passes to the main conveyor which may be either a slowly moving belt or a trough with a chain.

Conveyors may be of several types, chief among which are belt, chain, and gravity conveyors. A fourth rather common variation of a conveyor is the simple slide.

Where practical, gravity conveyors are the most economical conveyors for a dimension-stock plant. They are convenient in that sections can be set aside to make a passageway in case of need or the whole conveyor system can be easily shifted if need be. It may be tried out in various positions until the best location is found. Gravity conveyors may save labor in loading and unloading trucks or wagons when stock is being transferred from mill to storage or in some stage from storage to car for shipment.

Gravity conveyors require at least one-half inch drop in elevation for each lineal foot in length. Thus a conveyor 50 feet long requires a graduated drop of 25 inches. Naturally the greater the drop the faster stock will travel between positions. Booster chain conveyors operated by small electric motors can be installed where the length of the gravity conveyor is so great that the height of the first position is not enough to provide the required degree of incline throughout the entire distance the stock is to be transferred. The booster conveyor is simply a means of lifting the stock to a new elevation where it can start down on a new series of rollers.

An advantage with gravity conveyors is the feasibility of using curved sections, thus making it possible to convey stock around corners. Turning corners is not impossible with other types of conveyors, but such installations are complicated.

Gravity conveyors with rollers spaced close enough to handle short stock effectively can be installed for about $3 per lineal foot. The roller sections can be bought from firms specializing in such equipment and the supports or trestles for the sections can be constructed in the plant to meet the particular needs of each installation.

Roller conveyors of a sectional type would be convenient and labor saving in some instances in the following locations: Between the cut-off saws and the ripsaws, between the ripsaws and the glue jointer, between the ripsaws and the lathe, and between the sander and the bundling and storage room. Other opportunities would be found where stock could be transferred considerably cheaper by conveyor than by truck. Where it is necessary to sort stock coming from a machine, as is frequently the case with rough stock back of

the cut-off saws, a conveyor does not work to advantage. The use of two or three trucks to take the various lengths, widths, or qualities of cuttings may be unavoidable. In some cases both trucks and conveyor may work to advantage. The cuttings that are to go directly to the ripsaw may be placed on the conveyor and the others piled on trucks. If an operator appreciates the fact that it actually costs more to transfer material up to and away from machines than it does to run it through the machines there is a strong probability that the methods by which this cost item may be minimized will receive close attention.

Frequently a simple slide is an effective labor saver. A smooth wide plank or two with strips nailed along the edges to prevent stock from sliding off will bridge the distance from a pile to a car

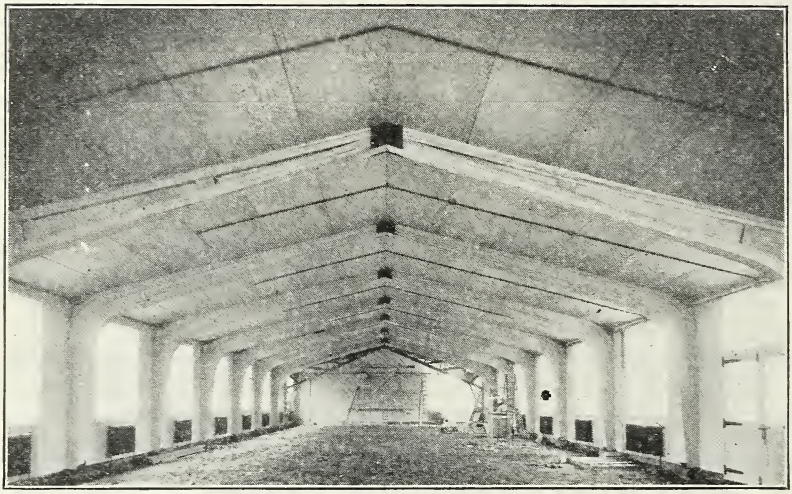

FIGURE 30.—A well-lighted modern shop with plywood roof supported by laminated wooden arches that eliminate the need for columns.

being loaded or from a pile to a kiln car or in other similar situations. It is common practice for workmen repeatedly to climb up a dimension-stock pile for armfuls of stock, get down, walk 10 or 15 feet, and then deposit the material when simply an inclined smooth plank between the two points would effect the transfer in a small fraction of the time.

To operate a system of conveyors satisfactorily demands the characteristic progressive routing of straight-line production. Backtracking and continual shifting from one side of the shop to the other offset the advantages of conveyors.

SHOP CONSTRUCTION

The importance of a well-lighted shop should be recognized in planning a dimension-stock plant. Plenty of windows for light and ventilation and plenty of electric lights when daylight is insufficient are essential. A type of one-story building coming into more general use is that having an arched roof with truss support to eliminate the need for supporting columns (fig. 30).

Floors preferably should be of wood for comfort of workmen and to facilitate the placing of fastenings. They should be heavy enough to prevent sagging under the weight of heavy machines or heavy loads of lumber and should be level to enable free movement of loaded trucks. Good solid floors in large measure prevent vibration, which tends to throw machines out of adjustment. Motors hung from ceilings cause considerable vibration. Preferably machines should be direct motor driven, or motors should be mounted on the floor. As a preventive measure against accident there should be nonslip floor mats or abrasive metal plates where the workmen stand at machines.

The loading platform should be under roof both for the protection of the material being shipped and in order that loading can be accomplished in any kind of weather. The platform should be of solid construction, level, and of even surface so that trucks can be pushed about without difficulty. Broken or sagging floor boards should be replaced as soon as discovered.

DIMENSION-STOCK PLANT OPERATION

The crew required to operate a dimension-stock plant of 8,000 board feet daily capacity normally is made up of 25 men as follows: 1 shop superintendent, 1 millwright, 2 cut-off sawyers, 4 men at the ripsaws, 2 men whose time is divided between the glue jointer and glue room, 1 man whose time is divided among the bench or variety saw, scroll saw, and hand jointer, 2 men to operate the planer, belt sander, and drum sander, 1 man with time divided among shaper, lathe, and relieving men at other machines, 1 man moving trucks about the shop, cleaning up shavings and sawdust, and dusting machines, 2 bundlers, and 2 loaders. Aside from the shop crew there should be 1 lumber inspector, 1 dry-kiln operator, and 2 lumber pilers who would also take lumber trucks from kilns and deliver them as needed to the machines in the shop. In the heating plant there would be 1 man firing during the day and 1 at night.

Naturally, the organization of the crew will vary considerably from that specified here. There are a few machine jobs at which it is possible to keep men definitely located, but as a rule the location of the men depends largely upon the demands of the particular jobs in hand.

SHOP SUPERVISION AND INDIRECT LABOR

The mistake is often made of expecting the superintendent of a dimension-stock plant to keep all shop operations up to their highest level, keep machinery running properly, do the filing, operate the dry kilns, and incidentally play the roles of lumber inspector and cost clerk. The surprising thing is the ability of some superintendents to do credit to the heavy overloads they carry. There are more numerous cases, however, where there is clear evidence that the work of the organization as a whole would be benefited by better distribution of supervisory and allied overhead activities. The main job of the shop foreman should be to make certain that stock proceeds through the shop in orderly fashion with the least possible waste of raw material and in the shortest possible time consistent with

the quality of work the product demands. In a small dimension-stock plant he will probably have some time he can spare for other work, but in a large, busy plant it is poor economy to expect him to devote much of his time to extra activities, such as dry-kiln operation, lumber inspection, or other time-consuming tasks. Lack of supervision brings a train of troubles in the way of wasted material, ineffective labor, poorly dried and manufactured stock, and consequent marketing difficulties.

Dry-kiln operation is a job that requires ability and attention at critical periods in the run. An operator should not be tied down by some possible shop job that would prevent his giving attention to the kilns at the proper time.

In a small dimension-stock plant the millwright and filer jobs might be combined, as is often done. Filing needs are seldom so pressing that they stand in the way of emergency calls for millwright duty. The filing requirements in a small shop do not constitute a full-time job of one man, and the same may be said of the millwright job, provided the plant is not equipped with obsolete machinery that is constantly in need of attention.

If lumber is purchased on grade it is essential that the dimension-stock plant employ a qualified lumber inspector. An average daily rate of lumber inspection for the class of lumber cut in the New England States is 12,000 board feet, which is also the amount a dimension-stock plant would require for an output of 8,000 board feet of finished product. Hence, the inspection work would require practically the entire time of one man.

SHOP LAY-OUT

The lay-out plan shown in figure 31 is for a dimension-stock plant of 8,000 board feet daily capacity. The plan presupposes that each piece of equipment will be individually motorized and therefore independent of line shafts. This presumption offers the widest opportunity to arrange machines with respect to convenience in relation to other machines. If steam power is used with machines driven by belting from shafts, machine arrangement will have to be governed more by power demand, for instance the planer, a heavy power consumer, performs best when placed as close as possible to the source of power. With individual power units flexibility in location is unlimited.

ROUTE OF MATERIALS IN PROCESS

In order to demonstrate the effectiveness of the plant lay-out shown in figure 31 it is helpful to trace an imaginary lot of lumber from the time it is in the kiln-drying stage up to its loading condition.

A truck load of round-edged lumber is pulled from the dry kiln and immediately transferred to one of the conditioning or dry-storage rooms, where it remains until needed in the shop. It is then transferred to one of the lumber lifts alongside a cut-off saw and lowered until the top course of the load is about on a level with the cut-off saw table. The sawyer transfers the boards to the table and cuts them into the desired lengths. When cut to the proper lengths the stock is piled on factory trucks, and the end trims or other waste parts are pushed into a chute which leads to a waste conveyor. The

waste conveyor runs beneath the floor about midway between the cut-off saws and the ripsaws, and underneath the belt sander and hand jointer, thence out to a waste-storage compartment. The truck con-

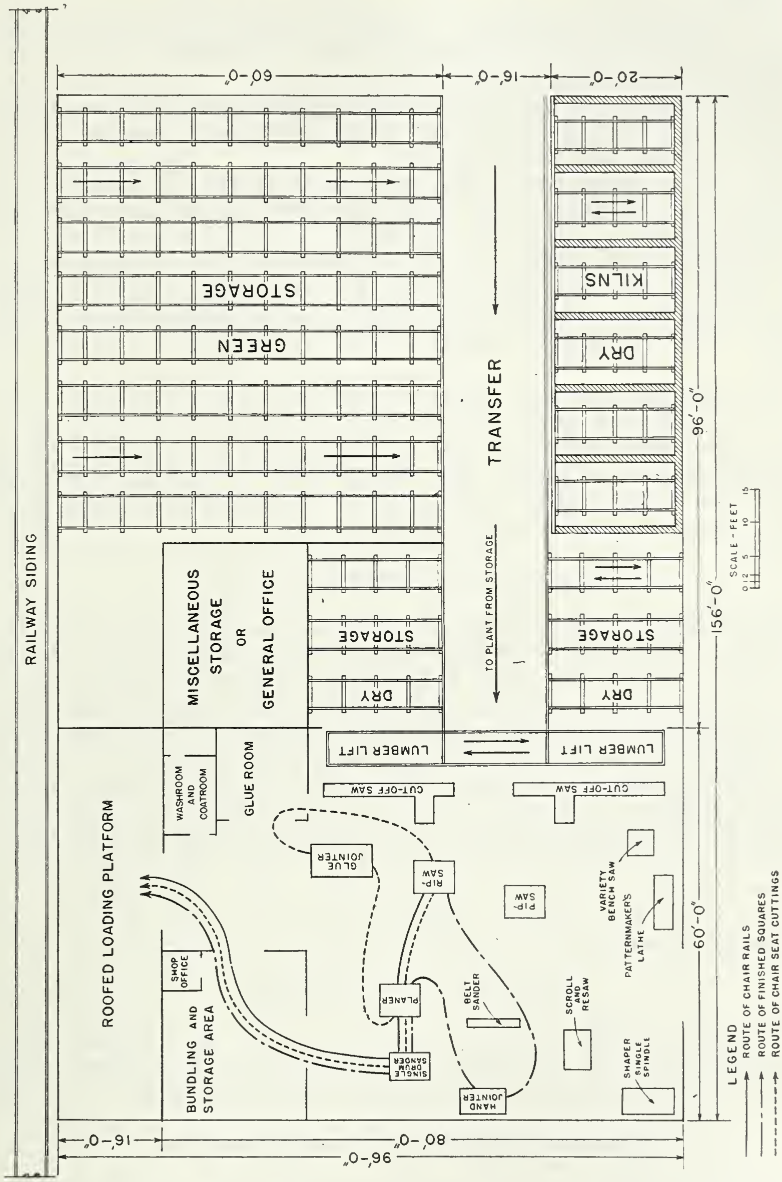

FIGURE 31.—Suggested lay-out of a dimension-stock plant of 8,000 board feet daily capacity.

taining the stock cut to the proper lengths passes to a ripsaw where the round edges are eliminated and other proper ripping done. The edging waste is dropped through chutes to the waste conveyor. From the ripsaw the cuttings may go various ways depending on what the product is to be. If it is to be chair seats the cuttings will pass in

the following order to the planer, glue jointer, glue room, ripsaw, planer, sander, and temporary storage. The only back-tracking necessary in this instance is when going back from the glue room to the ripsaws.

If the product is to be chair rails the cuttings go from the ripsaw to the planer, thence to the sander, thence to bundling and storage without back-tracking at any point.

If the product is finished squares the cuttings go from the ripsaw to the hand jointer, thence to the planer, thence to the sander, thence to the bundling and storage room.

The shaper, lathe, band, and bench saw indicated in figure 31 are set off out of the way for the reason that they are less used than the other machines.

A trucking aisle 10 feet wide at its narrowest point runs through the center of the shop. It will provide a convenience which is lacking in most shops, namely, an unobstructed passageway which will permit rapid transfer of material from one end of the shop to the other.

Enough space has been left ahead and behind one ripsaw and the resaw so that long lumber can be machined if there is need for it. The sander and the planer are so placed that all but the longest standard lengths of lumber may be handled. If thought advisable the lay-out could readily be changed by setting these machines so as to give ample space for longer lengths.

BUNDLING AND STORAGE ROOM

The bundling and storage room indicated in figure 31 is of minimum size. It is 22 feet wide by 27 feet long, out of which is taken space for a small shop office 6 feet square. It frequently happens that items for some carloads of dimension stock may be in process of accumulation for weeks. The stock cannot be stored outside to be damaged by the weather and it should not be stacked in corners and passage lanes in the shop. The only practical solution to the storage problem, therefore, is to provide a special room for that purpose. The room as planned for this dimension-stock plant is intended also as a bundling room, for bundling should be carried on adjacent to the supply of finished stock. The small office in the storage room will furnish sufficient convenient desk space for the foreman's records, stock shipping records, and the like.

WASHROOM AND COATROOM

Provision is made in the plan shown in figure 31 for coat, wash, and toilet rooms in one corner of the dimension-stock plant. The rooms are small but will accommodate a crew of 25 men.

GENERAL REMARKS ON PLANT PRACTICE

Good appearance, orderliness, and ample light in a dimension-stock plant exert an influence that is more far reaching than most operators realize. Men working in a plant that is well kept are inclined to do their work more neatly than those in a plant that is in a pell-mell condition. Not the least benefit that comes as a result

of a well-appearing shop is the good impression formed by prospective customers who may chance to visit.

The secret of a well-kept plant is insistence that each individual assume responsibility for keeping areas about certain machines in good order. Aside from the machine operator's attention to these matters there will, of course, be the usual attention of millwright and clean-up man. The combined efforts of foreman and crew will keep a dimension-stock plant in presentable condition with an appreciable decrease in cost over methods that leave a plant in a constant state of disorder.

The fire danger in a dimension-stock plant can be reduced in large measure by keeping machines properly oiled, adjusted, and cleaned, by keeping debris and oily rags picked up, by prohibiting smoking, and by having a properly distributed supply of fire extinguishers. If fire-suppression facilities are poor, fire-insurance rates may warrant the installation of a sprinkler system. Attractive fire-prevention placards should be posted in conspicuous places.

WASTE DISPOSAL AT THE DIMENSION-STOCK PLANT

There are few practical ways in which a dimension-stock plant can dispose of its waste at a profit. It is important, however, that an operator exhaust every possibility in an endeavor to make waste at least pay for its disposal. Occasionally, because of exceptional resourcefulness of an operator or because of advantageous location with respect to some special market, it is possible to make the waste business a worth-while part of the operation. For most plants the only apparent outlet for waste is the fuel market. Even this old stand-by has lost much of its dependability because of the extensive displacement of wood by other forms of fuel.

The following paragraphs discuss some of the uses to which wood waste may be put. They may suggest how to go about finding local markets that will turn waste into profitable channels instead of saddling the operator with an added expense. If one does not have considerable time that can be spared to this phase of the business it is preferable to place the matter in the hands of agencies specializing in waste disposal.

KINDLING

The finer parts of the waste at a dimension-stock plant, edgings especially, when cut into sections as short as 4 inches long still find rather extensive use as kindling for stove, fireplace, and furnace fires. It is generally bagged after drying, and is sold either by the pound or by the bag by fuel companies or department stores in much the same way that small quantities of charcoal or coke are sold. The markets for this product undoubtedly could be expanded appreciably if the public were apprized of the fact that wood in such form can be obtained as conveniently as any other commodity stocked by department stores. Relatively speaking the price that it brings is high, but for the purpose to which the wood is put the price is considered reasonable by the user. Much of the usual run of plant waste is too large to handle without first being ripped. A multiple ripsaw which will cut wide slabs into strips is a labor and power

saver for this operation. If the ripsaw is to be used only for this purpose a cheap second-hand or rebuilt machine is good enough. Additional equipment necessary for economical production of such kindling consists of a multiple cut-off saw with saws spaced 4 inches apart or whatever spacing is necessary to produce the desired lengths. A conveyor of some type that receives the cuttings as they drop from the saw and deposits them at a convenient point is a labor-saving arrangement worth considering.

BAKERS' WOOD

The demand for bakers' wood still holds up well for commercial bakeries in the larger cities. The woods used are chiefly maple, birch, hickory, oak, or ash. Air-dried edgings are cut in lengths usually of 24 inches and are bundled and shipped in this form. Reasonably fine sticks are preferred in order that a quick, hot fire will be produced. Dimension-stock edgings that are cut from kiln-dried lumber are ideal for bakers' wood. Cut from 1-inch lumber the widths of the edgings are generally less than 1½ inches. Such material is clean to handle and it yields a fairly smokeless, quick heat.

Although the demand for bakers' wood is fairly steady, the market for this product is probably capable of little if any expansion. In large measure the individual baking concerns are supplied with wood as they need it through the agency of large distributors of wood waste of various sorts. The system works well, for the distributor can devote his time to the needs of users and can draw on sources of supply as the demand arises.

HOGGED FUEL

Wood cut by a mechanical chipper into small chips for fuel is designated as hogged fuel. Hogs are common in large sawmills but are not practical equipment for a small mill. The controlling factors are so many that it is impossible to state how large a cut a sawmill should have before a hog is justified. Where there are possibilities of developing a market for hogged fuel and where sawmill conditions are favorable this form of waste utilization is worthy of consideration.

MINE TIES

Mine ties are usually about 4 inches square and vary in lengths over 5 feet. Aside from the requirement that the material be sound there is no restriction on knots or other defects that do not impair the strength or serviceability of the piece. Where there is an available market for mine ties a fortunate means for disposal of knotty and otherwise defective but sound hearts is afforded. Still other mine and railroad materials where some possibility of waste disposal exists are mine timber caps, shims, and tie plugs.

SNOW FENCES

The market for snow-fence slats for highway and railway use has been a large and growing one during recent years. It furnishes an outlet for sound but otherwise defective material that may be cut from hearts or slabs.

MISCELLANEOUS USES FOR SAWDUST, SHAVINGS, AND OTHER MILL WASTE

Sawdust is used for fuel, as an absorbent, in composition products, wood flour, for cleaning and dressing furs, as metalware polish, for packing in leather work, in sweeping compounds, wallboards, meat smoking, and for many other minor purposes. Among the many uses for shavings the most common are as stable and kennel bedding, packing, fuel, meat smoking, and as a component of wallboards. Larger pieces of waste are in some cases used in manufacturing products of distillation. However, at present this use is decreasing rather than increasing.

DIMENSION-STOCK BUNDLING

Essential in any dimension-stock operation is a carefully developed bundling scheme. Good bundles are as important in successful dimension-stock marketing as good cans in marketing canned goods. Good bundling accomplishes three distinctly worth-while objectives, namely: (1) It increases respect for the product; (2) it protects the stock from damage incident to handling; and (3) it reduces handling costs both at the mill and at the consuming plant.

Bundles may be of two types—loose or rigid. Loose bundling is a more or less temporary measure used chiefly for grouping pieces of rough stock to facilitate handling. It offers some protection to stock, and if used with green material it is less liable to cause staining than is the case with rigid bundles. Loose bundles are generally tied with twine or soft wire. As the bundling operation is usually performed it is virtually as expensive as rigid bundling, and the results are far less satisfactory. Loose bundles are difficut to handle without pieces slipping out and completely disorganizing the bundle. Moreover they add little to the appearance of the stock, and they are not effective in preventing warping.

Rigid bundles may be tied with wire or with metal strap (fig. 32). Machines are available that do an effective job of tying. Such bundles furnish a high degree of protection to stock, and they are neat in appearance besides being easily handled.

Further protection is given stock by placing guard strips of wood one-eighth to three-sixteenths inch thick under the straps or wires. The strips extend beyond the edges of the bundles about one-eighth inch in order to prevent the binding from cutting the corners.

High-grade, dry dimension stock may be given necessary additional protection by wrapping it with strong kraft paper as shown in figure 32, *C*. Practically complete protection is thus afforded the stock from ordinary transportation hazards and temporary exposure to rain or snow.

The expense of bundling varies with the skill of workmen, size of bundles, kind of binding material used, number of ties per bundle, and size of stock bundled. The value of the stock largely determines the bundling expense justified. Bundles should be of the maximum weight that can be handled by one man throughout the day, approximately 60 pounds. The cost of binding material depends on the number of ties per bundle and the number of ties depends on the length of the stock and the security required. In some cases

stock as long as 16 inches may be securely bundled with a single tie about the middle. Longer stock may require a tie at each end and heavy bundles subject to rough handling may require as many as three ties, one about the middle and one at each end. A good

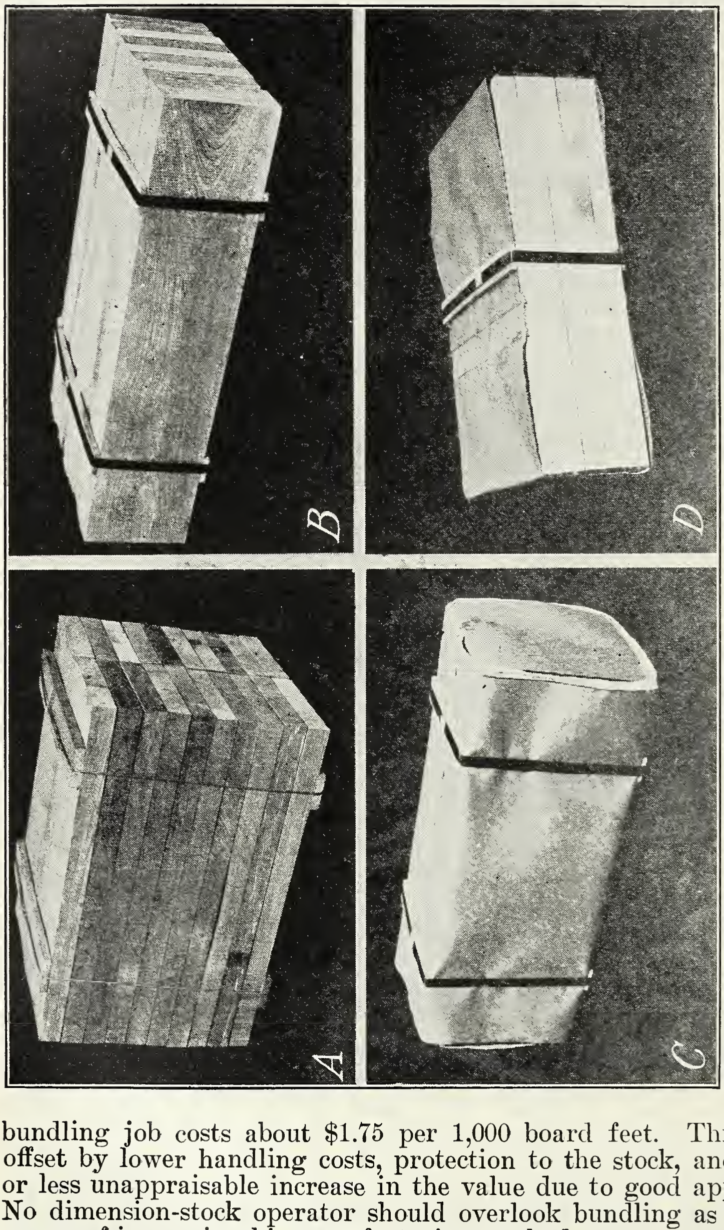

FIGURE 32.—High-grade dimension stock ready for market: *A*, Wired bundles of dimension stock. Guard strips or other protection is necessary to keep corners and edges from being cut or stained by contact with the metal. Squares to be turned do not need such protection. *B*, Metal strapped bundles of dimension stock with guard strips of wood to protect edges and corners of the stock in the bundle. *C* and *D*, High-grade dimension stock wrapped in lined kraft paper and strapped with metal. Adequate protection is provided against damage by weather and mechanical injury incidental to handling.

bundling job costs about $1.75 per 1,000 board feet. This cost is offset by lower handling costs, protection to the stock, and a more or less unappraisable increase in the value due to good appearance. No dimension-stock operator should overlook bundling as a simple means of improving his manufacturing methods.

ESTIMATED COST OF PRODUCTION

Along with estimates of mill and shop construction and equipment costs it is consistent to include some estimates of the cost of producing dimension stock all the way through from the log to the finished product loaded on cars ready for market.

Starting with logs valued at $12 per thousand board feet at the mill, lumber delivered at the cut-up shop would cost $30 per thousand board feet. Kiln drying would add $6 more, shop labor and overhead would add $15.13, other overhead items—administration, office expense, selling—$3.08, or a total production cost of $54.21 per thousand board feet.

In computing shop-overhead expense, interest on investment was figured at a 6-percent rate, depreciation at 10 percent per annum, taxes at 15 mills, insurance at $0.15 per $100 per annum. Production rate was taken as 8,000 feet of finished stock per day for 300 working days per year.

The output of 8,000 board feet of finished stock per day is an item that cannot be broken down into the various classes of stock of which it will be composed. The following classes will be represented but in uncertain amounts: Air-dried rough stock, kiln-dried rough stock, surfaced square-edged stock, sanded square-edged stock, rough-turned or turned and finished, shaped, glued-up and sanded, glued-up and band-sawed, glued-up and shaped, bundled, and unbundled. No doubt there also will be several other types of stock aside from those mentioned.

SEASONING OF DIMENSION STOCK

Poor air-drying methods are responsible for a greater waste of lumber in New England woodworking plants than any other single cause of avoidable waste. Outstanding among the factors that account for heavy seasoning losses are: (1) Poor stickers and poor stickering; (2) low and unstable pile foundations frequently made from defective timber; (3) no pitch or slope to piles; (4) all lengths piled together in a single pile; (5) different thicknesses piled in a single pile; (6) no roof boards or pile covers; (7) vegetation about the piles; (8) piles too small; and (9) poor yard location.

One or more of these factors result in end and surface checks, warp, decay, stain, and lack of uniformity in drying. In the dimension-stock plant excessive waste is necessary in eliminating defective portions and in stock not kiln-dried subsequent to air drying there may be serious warping, shrinkage, and checking after the parts have been assembled in the finished products. Heavy waste of material in processing increases production costs and prevents successful competition with manufacturers who can produce cheaply because of better drying practices and consequent lower cut-up losses. Poor dimension stock causes dissatisfied customers with resultant loss of business not only for the individual offending producer but also for the industry as a whole.

KILN-DRYING

Instances of kiln-drying dimension stock or lumber at mills in New England States are few for kiln-drying has been left as a job

for the factory. Modern kiln installations are exceptional. There are good reasons, however, why kiln-drying should be done at the sources of lumber production and the sooner dimension-stock plants assume a greater share of this responsibility the sooner will they fit properly into a well-coordinated woodworking system. It is one of the natural short cuts to lower costs. Some of the advantages in favor of kiln-drying lumber at the source of production are as follows:

1. Reduction of freight charges on stock shipped from dimension-stock plant to factory. The difference in charges is equal to the cost of shipping an amount equal in weight to the weight of the water eliminated in kiln-drying.
2. Cheaper kiln-drying due to the fact that labor costs, fuel, and various overhead items are lower at dimension-stock plants than at factories located in congested centers of population.
3. Refractory pieces that in kiln-drying are rendered unfit for use can be left at the plant instead of paying transportation charges on them from plant to factory and then after drying throwing them out at the factory. Shipping charges, handling costs, and other items of cost that would be incurred in shipping defective stock are thus eliminated.

LAY-OUT FOR DRY KILNS AND STORAGE AREAS

About one-half of the total output of a dimension-stock plant goes into uses in which kiln-dried stock is required. The dry kilns and storage areas required for a modern dimension-stock plant of 8,000 board feet daily output when operated either as an integral part of a sawmill or as a concentration plant for outlying feeder sawmills should therefore consist of a battery of six-compartment kilns, a green-storage shed, and a dry-storage shed.

DRY KILNS

The six-compartment kilns indicated in figure 31 have a total capacity of 21,000 board feet, which means that the kiln capacity is about equal to 3 days' requirements for kiln-dried lumber of the dimension-stock plant. Each kiln is 10 feet wide by 18.5 feet long, inside dimensions. This size of kiln will accommodate kiln loads about 6 feet wide by 16 feet long with sufficient space about the sides and ends to permit the passage of a kiln operator whenever he desires to inspect the progress of drying. Further than to indicate approximately what the capacity of the kilns should be no other details of kiln construction will be given, since the advice of commercial kiln engineers should be obtained for further details in order that the problems peculiar to each individual installation will get proper attention.

A battery of six-compartment kilns will not be sufficient if the plant, in order to reduce the drying period, undertakes to kiln-dry green stock down to an air-dry condition. Some thought should therefore be given to ultimate needs, for there is economy in making a complete kiln installation at the outset over an inadequate initial lay-out and subsequent additions. In planning an extensive kiln installation the economy in construction and subsequent operation

of long kilns as an alternative to the single-compartment type shown in figure 31 should be considered carefully.

The principle on which a kiln operates must be considered along with size and number of kilns in arriving at output. There are several types of kilns on the market from which a prospective buyer may choose. A good kiln coupled with attentive and intelligent operation will go far in overcoming the hazards of fast drying.

The hazards of kiln-drying lumber and dimension stock are often overemphasized. It is a well-known fact that the conditions within a good dry kiln can be so closely controlled that material in it is exposed to appreciably less hazard than lumber being air-dried under exposure to the varying moods of the weather. The point to be stressed is that the degree of success in the seasoning of wood depends not so much upon whether natural or artificial means are employed as upon the extent to which advantage is taken of the opportunity to regulate conditions that are responsible for results.

The Forest Products Laboratory has been conducting research in kiln-drying for many years and it is prepared to answer requests for information on any phase of the subject.

GREEN-STORAGE SHED

Almost as essential as good kilns themselves are proper loading and storage areas. Material being loaded on trucks for drying should be protected from the weather in order that it will not be ruined before it reaches the kiln. A roofed trackage area is therefore indicated in figure 31. The roof over the trackage area may be of the cheapest kind of permanent construction provided it is sunproof and rainproof. The choice of materials will depend largely upon the location of the plant and the accessibility of low-priced materials. There should be a slight slope from the railway siding to the transfer area so that the loaded kiln cars can be more easily moved.

The green-storage shed proper (fig. 31) covers an area 60 by 70 feet. With truck loads 6 feet wide and 16 feet long its storage capacity is 24 trucks or about 84,000 board feet, which is equivalent to a 7-day run of the dimension-stock plant.

DRY-STORAGE OR CONDITIONING ROOM

A dry-storage or conditioning room is essential for the proper conditioning of lumber immediately after its removal from the kiln in order that internal stresses in the lumber may be reduced and also in order that the lumber may be held dry for a considerable length of time without picking up any appreciable amount of moisture from the atmosphere. The capacity of the dry-storage rooms required for a dimension-stock plant producing 8,000 board feet of finished product daily, one-half of which is kiln-dried, is 21,000 board feet. The kiln loads are shoved into the two storage rooms indicated in figure 31 on trucks just as they come from the kilns and they remain in the storage rooms until needed in the cut-up room. Thus only two lumber-handling operations are necessary, one when the lumber is loaded on the trucks at the railway siding and the other when it is pulled off at the saws.

CAPACITY OF DRY KILN FOR DIMENSION STOCK AND FOR ROUND-EDGED LUMBER

In order to present comparative costs of kiln drying material in the form of lumber as against drying the same amount of net usable material in the form of dimension stock the Forest Products Laboratory undertook to follow material through a number of the various steps involved in drying and handling of stock at a representative dimension-stock mill in New England. The kiln trucks used in the trials were capable of taking loads about 14 feet long, 5 feet wide, and 55 courses high of nominally 4/4 material. The maximum footage possible per course would be about 70 board feet, or 3,850 board feet per load. In piling dimension stock, intervals were left for vertical chimneys and other space was unavoidably wasted so that only 80.7 per cent of the available piling area was occupied, hence, the average volume per course was 56.5 board feet. The total volume of the load, therefore, was 55 by 56.5, or 3,107.5 board feet.

In loading round-edged lumber a mixture of widths and lengths was used. There were not enough long boards available to permit the best use of space. Nevertheless the piling was about what would ordinarily be expected in any piling job using this type of material. It was possible to use only 42.6 feet per course out of the 70 feet available because of the irregularities in outline of boards and the improper assortment of lengths. The total load was, therefore, 55 by 42.6 feet, or 2,343 board feet. On the basis of the scale of the material in the rough, the load of round-edged lumber had only 75 percent of the volume of the load of dimension stock (2,343÷3,107).

Based on the net volume of cuttings from the load of round-edged lumber the difference in capacity is much greater, for subsequently when the material was cut up by careful methods it was possible to get a yield of only 65.7 percent of cuttings from the round-edged lumber. Such cuttings were of the same quality as that of the load of dimension stock with which the comparison was made. The gross scale of the round-edged lumber when reduced to the cutting scale gave a volume of only 1,540 board feet (2,343 by 0.657), which is 49.6 percent of that for the dimension-stock load of comparable size and quality. Round-edged lumber, therefore, is at a disadvantage in the following respects: (1) For a given unit of cuttings, kiln-operation costs are twice as great or possibly even more because the drying rate for dimension stock is faster than that for lumber; (2) in loading and unloading kiln trucks and performing other work incident to charging and discharging the kiln one-half the time is spent on material that avoidably or unavoidably is wasted in factory cut-up operations.

Records indicate that it requires 8.7 man-hours to load a kiln truck with enough round-edged lumber to yield a thousand board feet of dimension stock as compared with 8.5 man-hours to load a truck with a thousand board feet of dimension stock. Thus, as far as the actual loading of the kiln truck is concerned, there is practically no difference in cost between dimension stock and round-edged lumber when the material is figured on a net cutting basis.

There are other items where the cost of handling round-edged lumber is twice that of dimension stock. For example, it usually requires about six men to charge and discharge a kiln; that is, to

push the truck up to and into the kiln and to pull it out at the end of the run.

Approximately the same length of time is required whether the truck is loaded with 3,107 board feet of dimension stock or with round-edged lumber having a net cutting volume of 1,540 board feet. The same is true of other handling operations, for instance, hauling the material from the sawmill or yard to the kiln and transferring it to the shop after drying.

KILN DEGRADE IN DIMENSION STOCK AND IN ROUND-EDGED LUMBER

Some operators contend that their degrade in drying dimension stock is no greater than that in drying lumber and on the other hand there are operators whose experience in drying dimension stock has been disastrous. In order to obtain definite information on this question the Forest Products Laboratory conducted a series of drying tests with New England woods.

In computing the results of the tests, the cuttings were grouped according to degree of drying defect into three classes, namely: (1) Cuttings practically without drying defect; (2) cuttings slightly defective but not enough so as to cause any loss; (3) cuttings with drying defects that probably would not machine out in the final factory operations. The results from this study showed that the defects in drying round-edged white birch accounted for a loss of 3.1 percent of the original volume; in drying dimension stock they accounted for 3.48 percent. In other words, from this study there appears to be no appreciable advantage in drying white birch in round-edged form. With maple, on the other hand, the results indicated a loss of 17.6 percent in volume when dried as dimension stock as compared with a loss of only 3.3 percent when dried as round-edged lumber. This does not mean that maple dimension stock cannot be satisfactorily kiln-dried, but it does indicate that in drying maple and white birch different kiln schedules are required, since for the more refractory maple the drying conditions must be more exacting. With both white birch and maple the size of log had no effect on the amount of drying defect. In this connection it is important to bear in mind that the cuttings dried were comparatively narrow, so that the influence of diameter of log was largely offset. Wide cuttings from small logs would undoubtedly cup more than wide cuttings from large logs.

DIMENSION-STOCK PILING METHODS

Piling dimension stock for drying falls under two heads, namely: (1) Piling for kiln drying; (2) piling for air drying. In the main the same principles apply to both. Actually, however, different methods are used and it is therefore necessary to discuss each separately.

PILING FOR KILN DRYING

In piling stock for kiln drying it is necessary to stack the material as closely as possible in order to conserve kiln space and at the same time have the piles open enough to permit proper air circulation. Since kiln operation is expensive it is essential that every effort be used to secure the maximum turn-over. However, material too

closely piled prevents good air circulation and thus retards the drying rate, causes nonuniform drying, and frequently is responsible for molded or stained stock. If stock is too openly piled not only is space wasted but the material may dry so rapidly that it casehardens, checks, or warps severely. Edge to edge piling of small stock may increase the volume of loads as much as one-third. Adequate forced horizontal circulation makes this method of piling practical.

Dimension stock needs good support at close intervals in order to prevent warping during drying. For good support three things are essential, namely: (1) Uniform thickness of adjoining pieces; (2) uniform thickness of stickers; and (3) stable foundations. For stock dried unsurfaced, responsibility for thickness rests with the sawmill cutting the logs. To insure uniformity in stickers they should first be dried and then the entire lot dressed to thirteen-sixteenths inch, 1 inch, or whatever standard might be set. Pile foundations on the kiln trucks must be of strong, dry material in order to remain level under a heavy load. Moreover, the intervals between timbers in the pile foundations must be small enough to prevent sag in the stickers supporting the first course in the load.

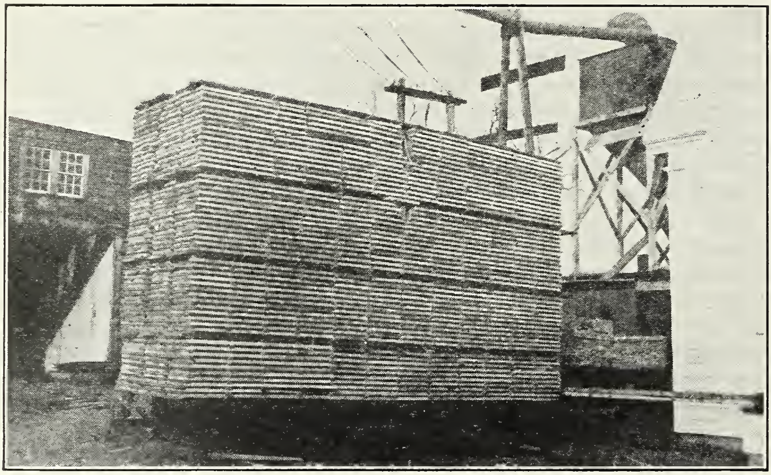

FIGURE 33.—Dimension stock piled on truck for kiln drying. Note numerous rows of stickers inserted to give support to the ends of the stock.

The methods of piling the stock depend largely upon the air circulation in the kiln. If the air circulates horizontally through the pile the pieces in a course may be laid flush against one another. If the air travels vertically through the pile the pieces in the course must be far enough apart to allow free circulation. In most piles intervals of at least 1 inch must be provided for vertical circulation and often in addition a chimney or possibly two must be built into the pile to insure positive ventilation.

Each piece of stock should be supported on stickers at least at both ends. If the stock is long it requires more support. No pieces should be piled with an unsupported span of over 16 inches.

Figure 33 shows a typical kiln load of dimension stock piled for a kiln in which there is cross circulation of air.

When rough stock that is to be reworked reaches the plant in bundled form it should be taken from bundles and repiled carefully on kiln trucks. Aside from slow and nonuniform drying of stock in bundles there is the likelihood of molding and staining of pieces on the inside of the bundle. Moreover, it is probable that dimension stock bound with wire or metal straps will be rust stained wherever there is contact between wood and metal. Still another difficulty with bundles develops as the stock dries and shrinks in that many pieces are left unsupported and free to warp.

PILING FOR AIR DRYING

Piling dimension stock under roof or in the open for ordinary air-drying permits of considerably more variation in size of piles and method of stacking than is possible when piling on kiln trucks. The chief difference is in the spacing of the stock. In air-drying an

FIGURE 34.—Well-manufactured dimension-stock cob-piled but sustaining heavy damage because of careless piling and poor pile foundations.

effort is made to increase the drying rate by opening the piles far more than would be practical in a kiln. At the same time it is necessary to take steps to prevent checking.

A number of forms of piles are employed in air-drying dimension stock in New England. In some piles the material is stickered with especially prepared stickers just as for kiln drying. In other piles material is self-stuck, that is, pieces of the stock being piled are used instead of special stickers. In still other piles the stock is cob-piled (fig. 34), that is, no stickers are used, but in the alternating courses of the pile the pieces run in opposite directions; for instance, if in the first course the pieces run north and south, in the second course they will run east and west, in the third course north and south, and so on.

Another method occasionally used is lap piling. Here again no stickers are used, except at the two ends of the pile. Elsewhere the air spaces in the pile are formed by end lapping adjoining pieces

(fig. 35). Naturally this system is better adapted to flat stock than to squares since squares lap-piled form an unstable pile unless a good method of joining together adjacent tiers is employed.

A method of piling dimension stock less frequently used is a triangular, open-center pile. It is employed with squares more than

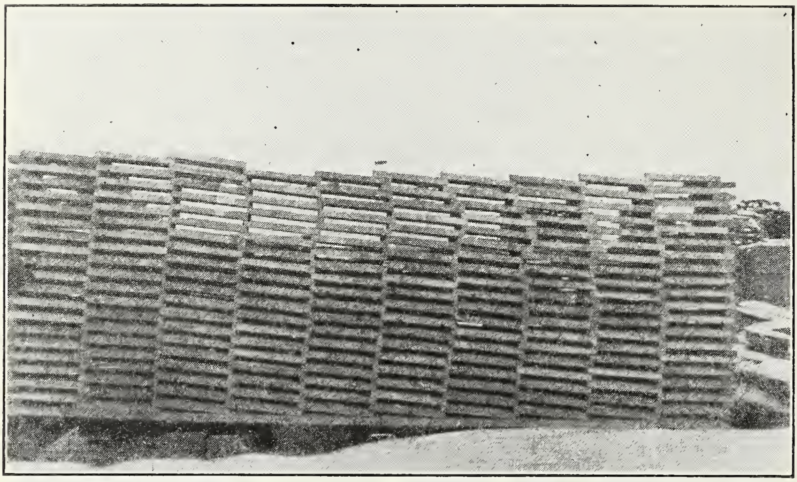

FIGURE 35.—Lap-piling of dimension stock.

24 inches in length. The sides of the pile are of the same length as the stock, for there are no breaks except at the corners. This method accomplishes rapid drying, but has numerous disadvantages. It is wasteful of space, impractical for short stock, and may result in staining, warping, and twisting.

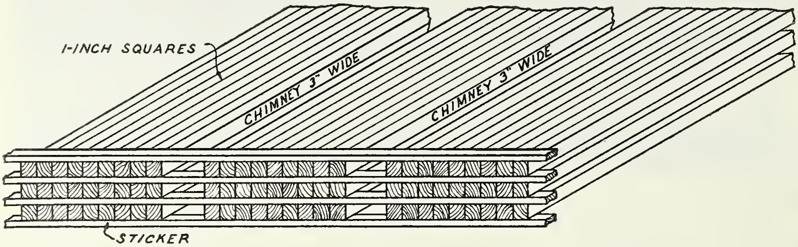

FIGURE 36.—Continuous chimneys 2 to 3 inches wide extending from the bottom to the top of the pile promote air circulation and result in faster and more uniform drying throughout the pile.

Some operators find that there is less warping if the pieces in a course are piled in contact with each other. This tends to prevent lateral warping although there is still the opportunity for vertical distortion. In order not to retard air circulation too greatly the courses are broken at intervals of about 1 foot so as to form continuous chimneys 2 to 3 inches wide from the bottom to the top of the pile. When this is done there is no limit, from the standpoint of air circulation, to the practical width of the pile. Figure 36 shows the general scheme of such piling.

Naturally such piling is especially advantageous with square stock, for with flat stock there is comparatively little tendency for pieces to warp sidewise. However, there is some advantage in speed of piling in being able to place pieces flush against one another instead of placing each one carefully a uniform distance from the adjacent one, and also there is economy in space. If flat stock is piled according to this method the same rule with respect to continuous vertical air chimneys should be observed.

The remarks made concerning piling stock in bundles for kiln drying apply with almost equal force to air drying. Conditions must be very exceptional before it is possible to avoid staining of bundled stock piled for air drying. There is also the difficulty of getting reasonably rapid and uniform drying. It is not unusual to find stock even in small bundles that has a moisture content of 25 percent after an entire year in the air-seasoning pile.

EFFECT OF TIME OF YEAR ON STOCK PILED FOR AIR DRYING

The time of year at which dimension stock is piled for air drying has considerable influence on the way the stock behaves during seasoning. Piled in the early spring when usually there are heavy prevailing winds the drying rate is fast and the tendency for stock to check is a factor against which special precautions must be taken. Summer-piled stock is more liable to stain than stock piled in other seasons on account of the hot and often humid atmospheric conditions prevailing during summer. It is therefore important to keep surfaces of summer-piled stock separated and to have stickers thick enough to allow air to circulate freely. Bundled stock is especially liable to stain during the summer.

Green stock piled during the late fall and early winter dries slowly. There is little tendency toward staining and checking. However, even in the midwinter newly piled green stock will end-check slightly especially where it is exposed to sun and wind. By the time spring and summer arrive the winter-piled stock is fairly dry on the surface, and past the stage when the liability to check and stain is greatest. Winter-piled stock usually dries out brighter in color than does summer-cut and summer-piled stock.

REDUCTION IN AIR-DRYING LOSSES

Improvements in air-drying practice that reduce air-drying losses (fig. 37) can be made with practically no increase in labor or other costs. Drying dimension stock in well-constructed sheds greatly reduces seasoning losses. Stickers or piling strips should always be of dry, sound material, uniform in thickness, and free from bark. In piles of long lumber there should be at least three rows of stickers and in dimension-stock piles the sticker rows should be not over 16 or 18 inches apart. Vertically the stickers should be one directly over another.

The first cost of good solid pile foundations may be higher than that of makeshift, unsound, unstable ones, but in the long run the good foundations cost less and practically eliminate a source of trouble that results in a large waste of material (fig. 34). The use of a cover on the pile may save from excessive warping and checking not only the upper two or three courses in the pile, but also the

ends of boards below. Moreover, it will prevent much of the water staining that ordinarily occurs throughout an uncovered pile. Such pile covers of low-grade lumber or galvanized iron are cheap and

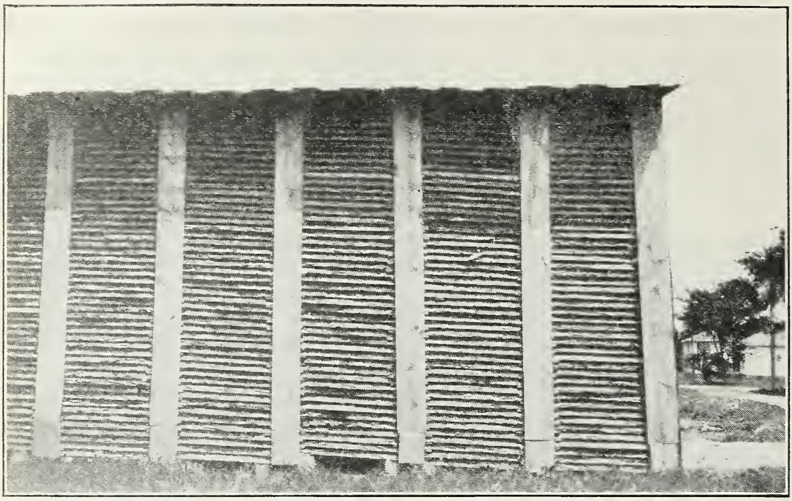

FIGURE 37.—Round-edged lumber 4 feet long carefully piled for air drying. Butt joints of piles are boarded up to reduce end checking. Temporary roofs give the material protection from sun, rain, snow, and wind.

will serve a long time. It costs no more to build piles that have a pitch sufficient to cause water to drain away than to build piles without pitch where the water seeps down through with resultant damage of various kinds (figs. 38, 39, 40).

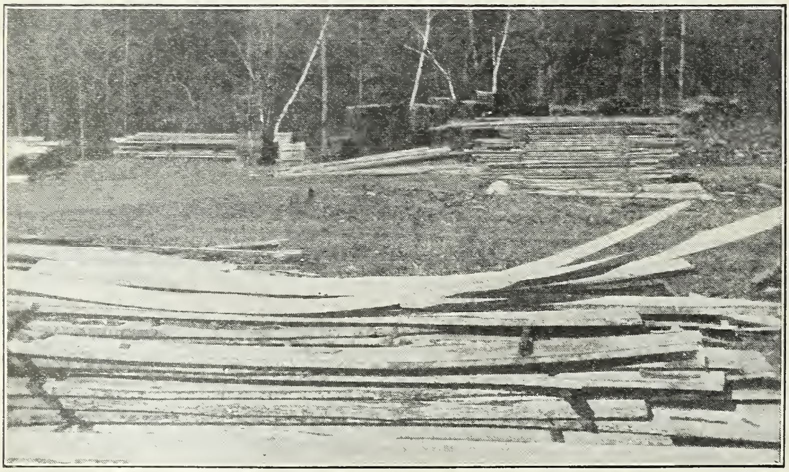

FIGURE 38.—A lumber pile with unprotected top. The total spoilage of material from this cause in New England is great.

AIR-DRYING SHEDS

The most satisfactory method of drying dimension stock outside of a kiln is in well-constructed drying sheds. Satisfactory kiln drying is impossible if lumber has been improperly cared for previous

to reaching the kiln. Stock protected from rain, snow, direct exposure to the sun, and more or less from dust and cinders comes through a storage period more uniformly dried, brighter, cleaner,

FIGURE 39.—Only one result can be expected from lumber piled for air-drying in this fashion—ruin for a large percentage of it. This poor piling job is typical of practice that is far too common in New England.

with fewer checks, and altogether more attractive to the buyer. Drying rates of stock in a shed and out in the open do not differ appreciably. What faster drying occurs in open-dried stock is very largely offset by periods of precipitation to which stock in sheds is not exposed. Piles in sheds may be left uncovered while being built,

FIGURE 40.—Exactly the same type of lumber as shown in figure 39 but piled in such manner that the seasoning loss will be comparatively small. It includes no features that are impractical in the average storage yard.

and when completed they require no special roofing. Another appreciable advantage in shed storage is the practicability of workmen piling and unpiling stock regardless of the weather.

An air-drying shed need not be an expensive structure. Generally described it consists of a well-supported roof, open sides, and no

floor. It should have strong timber sills capable of supporting heavy piles of stock. Sills and cross members should be arranged so as to keep the bottoms of the piles at least 12 inches off the ground.

Foundation timbers in contact with the ground should be of durable wood or better yet they should be given a preservative treatment to increase their period of service. It is preferable, however, to choose a naturally durable wood and use it untreated than to use nondurable wood that has been improperly or insufficiently treated. Good treatment may extend the life of a naturally short-lived wood several times.

Figure 41 shows a satisfactory drying shed 20 by 80 feet in size and constructed at a cost of approximately $800. If the long way of the shed runs north and south it is advisable to board up, partially at least, the south end gable and also to have available panels,

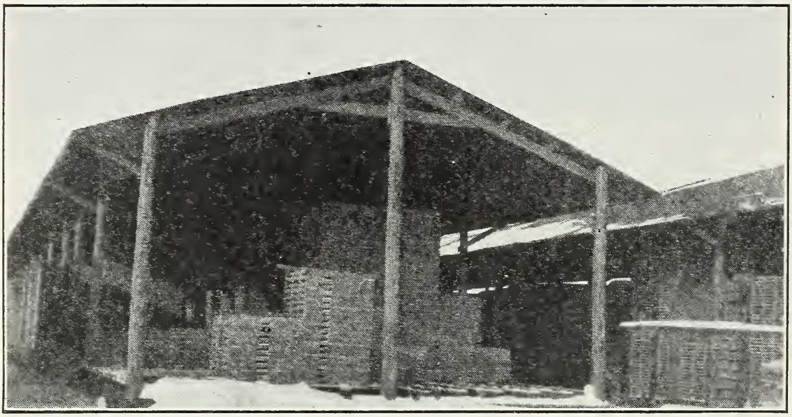

FIGURE 41.—Roomy open sheds that afford adequate protection to dimension stock.

canvasses, or other means for protecting temporarily any stock that may be exposed to the sun, hot drying winds, or precipitation.

The fact that dimension stock is piled in a good shed is not alone an insurance that it will dry properly. Piles must be arranged systematically and so spaced that air will circulate freely about them. Good foundations will largely prevent high narrow piles from toppling over against one another, but careful piling is also essential as a preventive.

For ease of access, stock of like dimensions should be piled in the same general location. If there are several sheds each should be used for some special type of stock; for example, one for squares, one for flats, or one for both 1-inch squares and flat stock.

PILE CARDS

Air-drying practice breaks down unless there are accurate records kept of the date when stock was piled. Piling records are also essential for inventory purposes, for intelligent handling of stock in storage, and for building up a fund of knowledge relative to required drying periods for various species, thicknesses of stock, and piling methods.

The record is best kept in the form of a card tacked to the pile or preferably placed in a card holder. The following items should appear on cards intended for dimension-stock piles:

DATE PILED

Since it frequently happens that a pile may not be completed for several days or weeks the card should indicate the last piling date. Different sections of the pile should each have a card showing when that particular portion of the pile was built. Care should be taken when combining left-over portions of piles to indicate the kind of stock in the new pile. It is not unusual to find piles composed not only of different species but also of stock cut at different times, hence varying widely in degree of seasoning. Dry stock is frequently buried under green stock. Temporarily it may be convenient to make such shifts, but the net result is inconvenience and disorder.

CONDITION WHEN PILED

Provision should be made for indicating whether the stock when piled was green from the saw, or partially dry, or, best of all, the actual moisture-content value should be recorded on the card.

DATE UNPILED

The date of unpiling is valuable for office and inventory purposes. It makes possible checking back to determine the cause for complaints of improper seasoning as well as to determine roughly the proper length of seasoning period under different methods of piling, different kinds and thicknesses of stickers, and the like.

CONDITION WHEN UNPILED

The only information called for on unpiling is the moisture content. To be of maximum use the figure should be accurately determined.

NUMBER OF PIECES, QUANTITY, BOARD FEET

A definite record of the contents of a pile is a convenience and timesaver. The number of pieces in some instances will probably be changed to number of bundles. In some cases no record will be kept of either pieces or bundles.

To encourage the use of pile cards several small, wooden, or metal boxes of cards should be placed in convenient locations in the shed. The card idea is equally applicable to open yard piling. However, cards placed on piles in the open must be well protected from the weather either by celluloid or glass-face holders or by galvanized-iron holders (fig. 42) bent so as to have a ledge projecting far enough in front to protect the card from the sun and rain. A strip projecting to the rear of such galvanized-iron holders and of a length sufficient to be inserted between the boards in the pile at any convenient height serves in place of any tack or nail arrangement for attaching the holder to the pile.

HOW TO DETERMINE THE MOISTURE CONTENT

The average moisture content of any lot of material may be determined in the following manner:

(1) Select representative pieces, being careful to include typical amounts of both heartwood and sapwood, taking about 1 out of every 100 pieces in the lot.

(2) In the case of lumber, trim from one end of each piece a length of about 2 feet, making the cut at a place free from knots, rot, pitch, streaks, and other defects. (The section must be far enough from the end to certainly avoid the effects of end drying; in addition, however, it is desirable to place the first cut so that the second one will leave the remaining piece of lumber sufficient for some standard length).

In the case of stock under 4 feet long, cut the test section from a point near the middle of the piece.

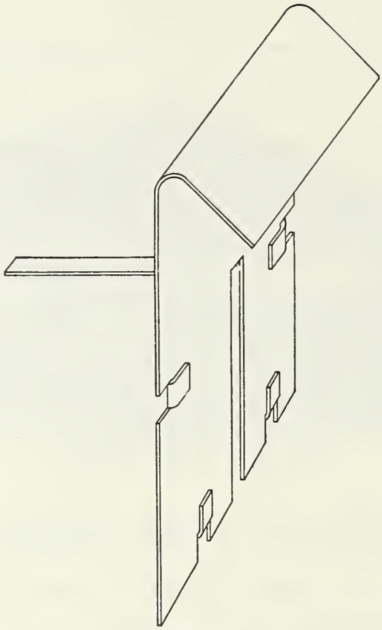

FIGURE 42.—A suitable card holder of galvanized iron.

(3) From the freshly exposed ends of each piece cut off a section three-fourths to 1 inch long in the direction of the grain.

(4) Trim all slivers off the sections.

(5) Weigh the individual sections immediately and carefully on a delicate balance. Each reading gives the original weight of a section.

(6) Place the sections in an oven heated to 212° F., or, if an oven is not available, on hot steam pipes, but do not scorch them; the maximum variation in the drying temperature should be not more than 5° between limits.

(7) When the sections have reached a constant weight, a condition that can be determined by repeated weighing, remove them from the oven. (After a little experience the time required to reach constant weight can be estimated with sufficient accuracy and some repeated weighings may thus be avoided. Twenty-four hours is about the maximum time necessary.) The final weight of a section is its oven-dry weight.

(8) Subtract each oven-dry weight from the corresponding original weight. Each difference, when the work has been properly done, is the loss in moisture of the section concerned.

(9) Divide the difference just obtained by the oven-dry weight and multiply the result by 100 for each section. Each final result is the percentage of moisture contained in the wood of a section, based on its oven-dry weight.

(10) Find the mean value of these individual percentages in order to obtain the average moisture content of all the sections. The result is considered the average moisture content of the lot of lumber that was sampled.

For convenience and accuracy the gram is preferably used in moisture determination as the unit of weight, but other units, such as the ounce, may be employed. The scales customarily used for moisture determinations, however, are graduated in grams; a fraction of a gram is conveniently expressed as a decimal.

An example of the calculation for a typical moisture-determination section follows:

Original weight=284.7 grams.
Oven-dry weight=180.2 grams.
284.7 grams−180.2 grams=104.5 grams of moisture lost.
(104.5 grams÷180.2 grams)×100=58 percent moisture originally in the wood.

There are several types of portable electrical moisture instruments now on the market for determining the moisture content of wood. The features common to the present instruments are two sharp metallic terminals that can be quickly embedded in the wood, batteries for supplying an electric current through the wood intervening between the two terminals, and a means for reading the resistance in the electric circuit directly in terms of the moisture content of the wood holding the terminals. The range of the present instruments is about 8- to 24-percent moisture content.

The electrical method has an advantage over the oven-drying method principally on account of its speed and convenience, the time required to determine the amount of moisture in any piece of wood being only a few seconds. The moisture determination is usually made on the back of the piece somewhere near the center. This procedure avoids marring the face when the metallic terminal points are inserted. The electrical method is the only known practical means by which the moisture content of finished woodwork in place can be determined without serious injury to the wood.

SUMMARY

The New England timber industry would be benefited by the introduction of modern methods of manufacturing, seasoning, and marketing. Type of ownership, quality of timber, and consumer demand favor the development and operation in New England of a few fairly large, advantageously located, well-equipped woodworking plants rather than those of small capacity, poorly equipped, and with restricted marketing facilities. Species and quality of New England timber lend themselves especially well to the manufacture of dimension stock; that is, stock cut at or near the point of timber origin into the sizes and shapes required by plants fabricating such articles as chairs, furniture, caskets, turnings, automobile bodies, toys, and containers. Raw material for such stock can either be cut by a mill department of the dimension-stock plant or it can be bought from neighboring small mills which do not have facilities for proper drying lumber or proper equipment for remanufacturing it to the form required for successful marketing.

A plant equipped with dry kilns and the minimum amount of machinery necessary for economical and efficient manufacture will cost, at 1932 prices,[7] about $57,000. Such a plant will rework 12,000 board feet of rough lumber each day of single shift. This is the equivalent of about 8,000 board feet of dimension stock in condition to go to the fabricating and assembling factories.

A sawmill equipped to supply the dimension-stock plant with 12,000 board feet of rough lumber each day would cost $8,000 in addition, or a total cost for a self-contained plant; that is, the sawmill and cut-up shop combined, of about $65,000.

The alternative to such a sawmill would be a group of six or eight outlying mills operating on a part-year basis.

Proper locations for the dimension-stock or concentration plants can be determined only after a thorough survey of timber ownership, available mill sites, transportation facilities, and potential markets.

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[7] See footnote 3, p. 8.

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